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A TREATISE
ON
SURGERY

BY

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BROOKLYN—NEW YORK CITY

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A TREATISE ON SURGERY

SECTION XVII

THE SURGERY OF THE DORSAL AND LUMBAR VERTEBRAE

FRACTURES

Fracture of the **spinous** and **transverse processes** is comparatively rare and unimportant. When the bodies and arches are involved, however, the injury is a most serious one. The spinal column is usually bent forward on account of the forcing down of the trunk by a heavy mass, as in excavation accidents, the inflection taking place between the eighth and the tenth dorsal vertebra. The spinous process of the vertebra the body of which is crushed projects backward at an acute angle (**kyphosis**).

Symptoms.—In addition to the **kyphotic curvature** above mentioned, complete motor and sensory paralysis, reaching from below upward to the plane of the injured vertebra, occurs from the crushing or division of the spinal cord. The bladder and rectum are paralyzed. Priapism is present. If any portion of the cord escapes injury at first, corresponding nerves and muscles may retain their functions for a time. These, however, become involved later on from the occurrence of **progressive myelitis,** due to interference with the nutrition of the cord. The parts above the point of injury become involved in the paralysis coincidentally with the occurrence of **ascending myelitis.**

If the catheter is not employed early in the case, retention of urine and dribbling of the accumulation (**ischuria paradoxa**), followed by alkaline decomposition, take place.

The insensibility of the skin and trophic disturbances lead to troublesome bedsores (**acute decubitus**). The sacrum and other pelvic bones may become bared, the patient dying from general septic infection.

Fracture of the arches occurs most frequently in the lower dorsal and lumbar region. Here the body is not bent, but the crushing force is transferred from the bony spinous processes to the arches, the latter giving way usually on both sides. Union takes place by connective-tissue formation and not by the formation of callus.

Symptoms.—The spinous process of the broken vertebra is depressed. Exceptionally the spinous process and arch may be displaced laterally (Lossen). Symptoms of concussion, rupture of the cord, and compression may also be present. Attempts to elicit crepitus should be very carefully made lest fresh damage be inflicted on the cord.

Dislocations of the Lumbar and Dorsal Vertebrae.—The dorsal vertebrae are rarely the seat of dislocation owing to the absence of mobility of the vertebrae on each other. **Flexion dislocations** and **rotation dislocations** are occasionally observed in the lumbar region. The diagnosis is made by observing the deviation of the respective spinous processes from the normal line. The cord is much less likely to suffer damage than in injuries in the cervical and dorsal regions. The same general principles laid down in treating of dislocations in the cervical region are applicable here.

Treatment of Fractures of the Dorsal and Lumbar Vertebrae.—The patient should be handled with the utmost gentleness in order to prevent further laceration of the cord. Opium may be given to allay pain. The bladder and bowels should receive attention. Bedsores should be prevented by placing the patient on a water-bed, and should be carefully watched and cared for when they occur. The application, for fifteen minutes, of a water-bag filled with cracked ice, followed by a hot antiseptic fomentation, is recommended. The utmost cleanliness must be observed and the parts exposed to urine and feces kept well powdered with lycopodium, talcum, or boric acid and oxid of zinc. The French preparation known as "papier Foyer" is useful as a protection to points of pressure. Electricity, massage, douches, and passive exercise are appropriate measures later on.

Operative Treatment.—Surgeons are not agreed as to the propriety of immediate operation in injuries of the cord occurring in connection with fracture. Owing to the impossibility of judging of the extent of the damage inflicted on this structure during the first few days, most surgeons prefer to treat these cases for a time by recumbency, and perhaps extension. Complete division or extensive laceration of the cord cannot be improved by operative interference and many cases of slighter injury recover without operation. On the other hand, it is claimed that immediate operation is indicated in all cases in which the arches are not forced forward sufficiently to destroy the cord completely. In the average case where compression of the cord persists or increases, operation may be undertaken with the view of relieving the symptoms of interference with the functions of the cord. This is particularly true of lesions in the lower dorsal and lumbar region. In the upper dorsal region (above the seventh dorsal vertebra) the results of operative interference are not so good. If the compression is due to displacement of the fragments of fractured arches alone, operation is demanded in any region of the spine. Removal of the broken arches will here suffice. If, however, in addition to this there is crushing and displacement of the body of the vertebra, the projecting portion of the latter must be removed by the gouge, chisel, or sharp spoon, the cord being retracted first to one side and then to the other side in order to gain space to effect this.

The Operation of Laminectomy (Macewen, 1886).—The patient is placed either prone, with an air-cushion beneath the lower portion of the chest, or in the left dorsolateral position (Sims's position). A four-inch incision is made in the middle line of the back. In case of fracture the center of the incision should rest on the site of the latter. The muscles are separated from one side of the two arches above and below the seat of fracture by clean cuts of the knife as far as possible and the remaining portions, together with the periosteum, pushed to one side with the raspatory. Large arteries are seized with forceps by an assistant. As soon as the bone is exposed the wound is tightly packed with compresses wrung out of hot water to arrest the hemorrhage, and the same procedure carried out on the other side. The interspinous ligaments are then cut across. A spinous process is then isolated and cut away with heavy cutting

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forceps and access gained to the spinal canal. When this is accomplished, the remainder of the arches are gnawed away by means of the rongeur forceps. The methods of osteoplastic resection (Urban) are unnecessary and a waste of time. The thick layer of fat overlying the cord is divided in the middle and pushed aside, and the dura exposed. If the latter does not pulsate, adhesion or swelling of the cord is probably present. The presence of blood beneath the dura will be denoted by a bluish or purplish appearance of the latter.

The cord, with its membranes, is now drawn carefully to one side and the bodies of the vertebrae exposed. In order to ascertain the exact condition of the subdural space, particularly in cases in which the operation is performed for tumors, etc., it will be necessary to open the dura; the edges of the incision in the dura are held apart by silk thread retracting sutures. This should be afterward closed with a continuous fine catgut suture unless some direct indication for drainage to relieve pressure exists.

The subdural and extradural spaces are now explored. In tumor cases if the neoplasm is situated on the surface it may be removed. If it encroaches upon the substance of the cord its removal should not be attempted. In fracture cases splinters of bone should be sought for, the remaining portions of the adjacent arches carefully examined and any irregularities corrected by the rongeur forceps. Projecting portions of the vertebral bodies are dealt with by the gouge or chisel.

A rubber drainage-tube is placed in position outside the canal for the purpose of draining the muscular portion of the wound for twenty-four or forty-eight hours, when it can usually be dispensed with. The edges of the muscular layer are approximated by buried catgut sutures and the wound in the skin by silkworm-gut. Copious aseptic gauze dressings are applied, these being changed as often as they become saturated by the discharge, which is very free during the first twelve hours. Special care is necessary to prevent infection by the discharges from the paralyzed bowel and bladder.

The chief immediate dangers of the operation are (1) those arising from giving an anesthetic in the prone or semiprone position with paralyzed abdominal muscles (White); (2) hemorrhage. The complications are (1) difficulty in clearing the canal; (2) difficulties in dealing with the fracture; (3) hopeless damage to the cord; (4) septic infections. Extensive resections of bone do not greatly nor permanently weaken the spine, particularly if care is taken to preserve the periosteum.

RAREFYING OSTEITIS OF THE VERTEBRAL COLUMN

At varying periods of time after the reception of an injury, generally, however, several months, the patient suffers from violent pains in the vertebral column, intercostal neuralgia, slight motor disturbances of the lower extremities, and gradually developing kyphosis. The lesion consists of a rarefying inflammation of one or more vertebral bodies. Though the vertebral column is only slightly contused or compressed, softening, absorption and atrophy of the surfaces of the vertebral bodies and discs take place, and finally perhaps the disappearance of these from pressure (Kümmel).

Treatment.—This consists of the recumbent position to relieve the parts from pressure, with extension applied to the head. After from two to four weeks a proper corset or a Taylor brace, with head support, should be applied. The pains quickly disappear under this treatment. The treatment will not correct already existing deformity. The rarefying process, however, being arrested, the patient is restored sufficiently to perform light work.

POTT'S DISEASE OF THE DORSAL AND LUMBAR VERTEBRAE (TUBERCULOUS SPONDYLITIS; GRANULAR OSTEOMYELITIS)

This develops by preference in the anterior portion of the bodies of the vertebrae. One or more of the latter may be affected. The sixth, seventh, and eighth are most frequently attacked (Billroth). The disease is relatively frequent in children from the third year upward. It may appear in adults, in which case it is coincident with general tuberculosis, or it may be quickly followed by miliary tuberculosis.

Clinical Course.—The two most characteristic features of osteomyelitis in the dorsal and lumbar regions are the formation of **anteroposterior curvature** (**kyphosis**) and **migrating abscess.** If one lateral aspect of the body of the vertebra is affected more than the other by the destructive process, a **lateral curvature** (**scoliosis**) is added. The abscesses usually have their origin at the posterior portion of the vertebral bodies and make their way to the anterior surface of the vertebral column. Their further course varies with the part of the vertebral column involved in the disease. Occasionally they arise at the lateral aspect of the bodies of the vertebrae, in which case they follow the direction of the transverse processes and appear at the dorsal surface. Invasion of the spinal canal by the suppurative process is almost never observed.

Abscesses arising from the **upper dorsal vertebrae** may invade the connective tissue in the posterior mediastinal space, giving rise to fatal **posterior mediastinitis,** and thence invading the pleural cavity, causing **suppurative pleuritis.** More frequently, however, they follow the course of the anterior longitudinal or common ligament of the spinal column, where they subsequently pursue the same course as those originating in the lower dorsal region. Occasionally abscesses from the upper and middle dorsal regions extend backward between the transverse processes and, crossing beneath the deep dorsal muscles, appear in the neighborhood of the angles of the ribs.

Affections of the **lower dorsal** and **upper lumbar vertebrae** give rise to abscesses which, by preference, follow the course of the psoas muscle (**psoas abscess**). Special facilities for the passage of pus from the region of the plane of the psoas muscle are afforded by the double row of slips of origin of this muscle from the bodies and transverse processes of the last dorsal and all the lumbar vertebrae. Abscesses from the upper dorsal region, upon reaching the points of attachment of these slips, may pass to either one side or the other; they occasionally follow both, and give rise to **bilateral psoas abscess.** In its further course the abscess usually follows the muscle to Poupart's ligament; it is comparatively rare for it to follow the muscle to its insertion in the trochanter minor. From Poupart's ligament it passes into the abdominal wall, finally pointing near the anterior superior spinous process of the ilium. In rare instances it leaves the psoas muscle at the sacro-iliac synchrondrosis and reaches the surface through the ischiorectal fossa, where it may be mistaken, after its discharge, for a fistula in ano. Or, it may pass through the great sacrosciatic notch and appear in the gluteal region. Finally, as a rare occurrence, the abscess may leave the psoas at an early stage of its progress and pass horizontally along the lumbar transverse processes to the origins of the quadratus lumborum, approaching the surface at the external edge of this muscle; or it may follow the inner surface of the transversalis muscle in the direction of the umbilicus, reaching the skin surface at varying distances from the latter.

Symptoms and Diagnosis.—The early symptoms are very obscure. Pain is generally absent, and, beyond a tired feeling when standing and walking, and a tendency to lean on some convenient object for support in order to take the weight from the vertebral column, together with a certain amount of **inflexibility** of the latter, there is in the beginning nothing to attract attention to the seat of the disease. As the disease advances the softened vertebrae are compressed under the weight of the body, and one or more of the spinous processes become comparatively prominent, and sometimes tender, marking the site of a commencing kyphosis. The inflexibility of the vertebral column now becomes more marked, the child, in stooping to pick up an object from the floor, restraining the bending movement of the spine and flexing sharply the hips and knees instead, with the latter in a squatting position (Fig. 399).

The **formation of abscess** may be characterized by a moderate evening rise of temperature, though this latter symptom is frequently absent. As the abscess approaches the surface its presence may be determined by inspection and palpation. It usually partakes of the character of a "cold abscess," until it reaches the skin surface, when the latter may become slowly reddened, and ulceration and perforation take place, the abscess emptying itself. After this, unless antiseptic treatment is instituted, the cavity of the abscess may become infected from without. The resulting fistulous track discharges pus continuously; occasionally small sequestra from the vertebral bodies are discharged.

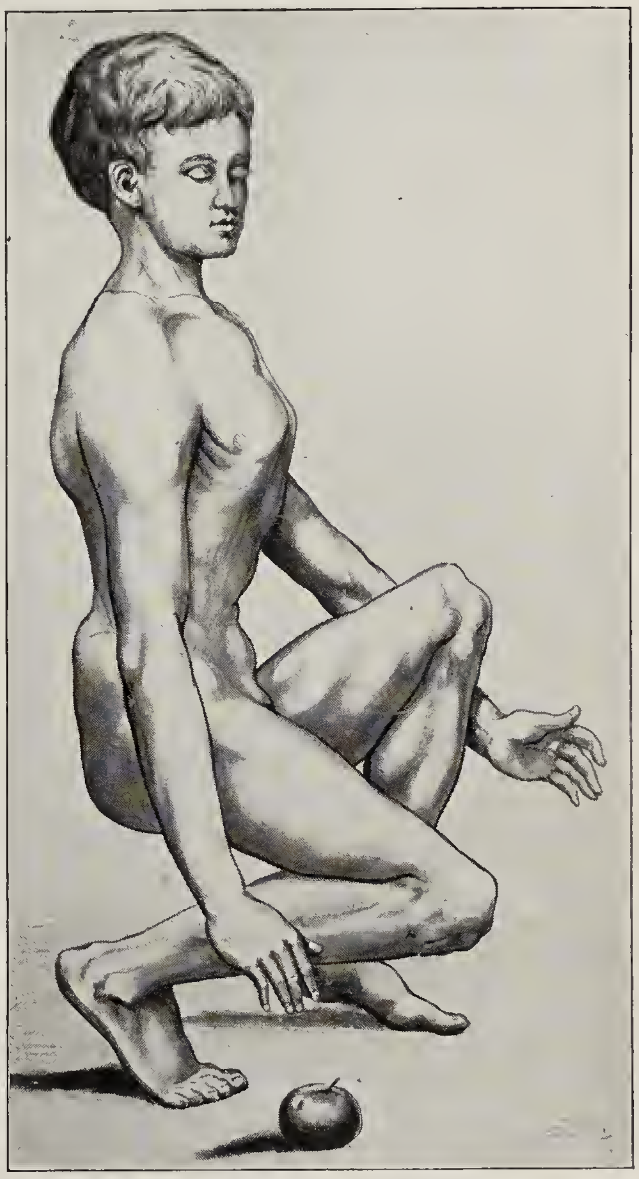

FIG. 399.—CHARACTERISTIC ATTITUDE OF PATIENT IN POTT'S DISEASE.

The **position of the patient in psoas abscess** is characteristic. The hip is slightly flexed in order to relax the psoas muscle, and sometimes rotated slightly outward, thus simulating commencing hip-joint disease.

Marked symptoms of interference with the functions of the spinal cord, when present, occur comparatively late in the disease. The earliest of these consist of **"girdlelike pains"** in the abdominal wall in the area of distribution of the lumbar nerves. Pains in the lower extremities and paresis of the muscles of the latter occur next. Finally, complete sensory and motor paralysis of the lower limbs is observed. These symptoms vary in extent and severity with the different degrees of mechanic pressure on the cord (see page 21).

Inflammatory curvature is to be differentiated from that of **rachitic origin** by the fact that the latter occurs between the first and the fourth year of life and the deformity disappears as the patient assumes the horizontal position. Rachitic kyphosis is not followed by suppuration.

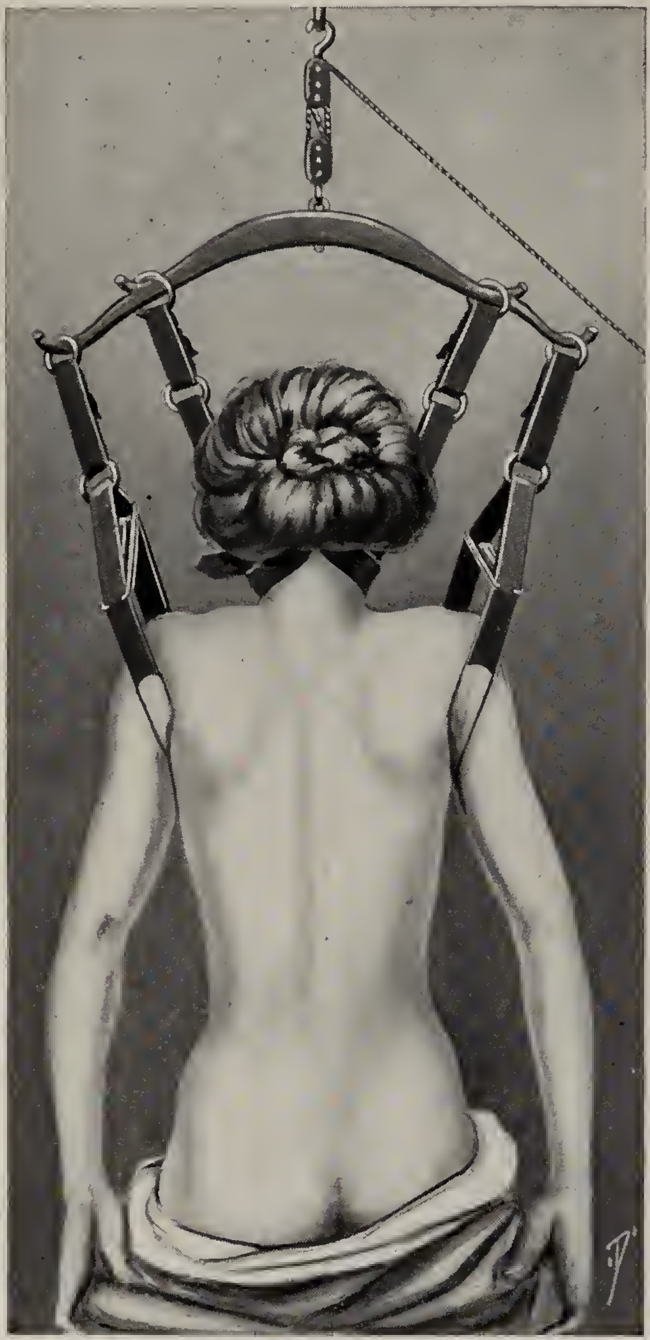

FIG. 400.—PATIENT SUSPENDED, READY FOR PLASTER-OF-PARIS JACKET (SAYRE).

Prognosis.—The **prognosis as to life** varies with the extent of the lesion, the resistance of the patient to general infection, the occurrence or otherwise of suppuration and the course which this pursues, the early or late recognition of the disease, and the period at which rational treatment is commenced. The **causes of death** are the following: (1) septicemia from infection of large abscess cavities; (2) exhaustion from prolonged discharge from the sinuses; (3) amyloid degeneration of the liver, kidneys, and spleen from prolonged suppuration; (4) general miliary tuberculosis (not frequent); (5) spinal cord lesions and their effects; (6) hemorrhage from erosion of large vessels (rare); (7) rapid fatal termination from perforation into the spinal canal (also rare); (8) rupture of an abscess into the pleural or abdominal cavity.

The **prognosis as to function** also varies. When but one or two vertebrae are involved and a rather moderate though angular-shaped kyphosis is present, the stature of the patient is not greatly shortened by interference with his growth. Where a larger number of vertebrae are involved, a more pronounced curve, followed by correspondingly deformed conditions of the thoracic walls, and a dwarflike appearance of the patient, is present.

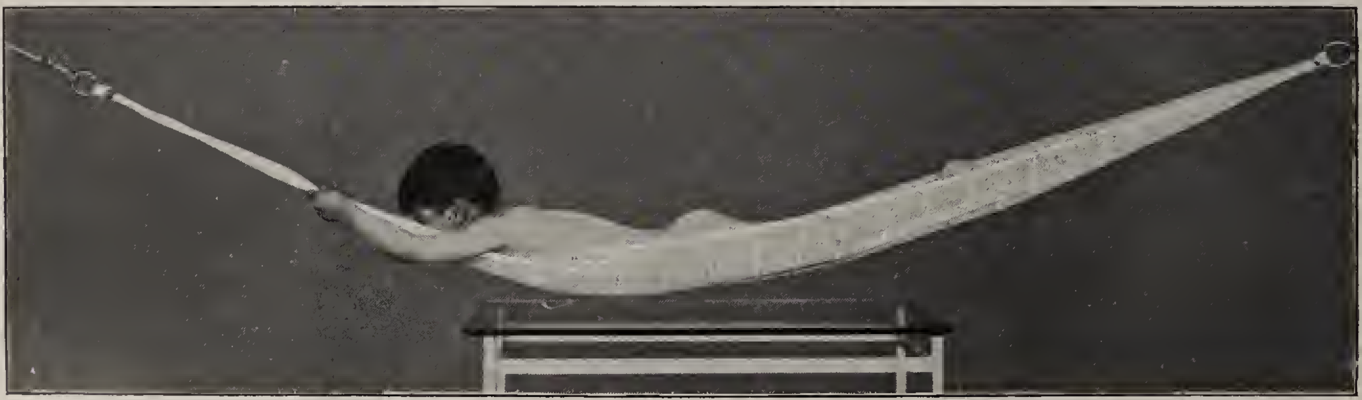

FIG. 401.—HAMMOCK SUSPENSION FOR APPLICATION OF PLASTER-OF-PARIS JACKET.

Treatment.—This resolves itself into (1) mechanic support; (2) constitutional measures; (3) operative interference.

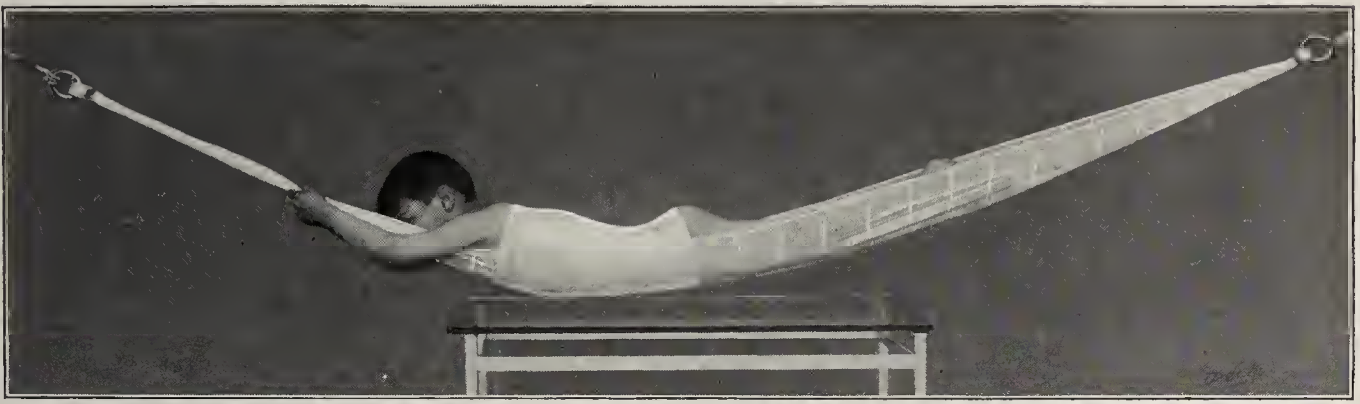

FIG. 402.—PLASTER-OF-PARIS JACKET APPLIED.

The **mechanic treatment** is of the highest importance. Its application should not be delayed after the discovery of the disease. While it cannot correct already existing kyphosis, on account of the processes of consolidation which have already taken place, progressive deformity is prevented by arrest of the disease. Two types of appliance may be mentioned, the one a solid fitting corset or cuirass of plastic material, applied while the patient is suspended (Sayre, Fig. 400) or while he is lying supine in a hammock in a position tending to correct the deformity (Richard Davy, Fig. 401), and the other a brace whose object is to open the angle anteriorly placed at the kyphosis and thus relieve the pressure on the diseased bodies of the vertebrae (Taylor, Fig. 404). The first appliance may be made either of plaster-of-Paris or of poroplastic felt material, the second appliance of light rods of steel with properly fitted and padded bands of webbing and leather adjusted and held in position by straps and buckles (Fig. 404).

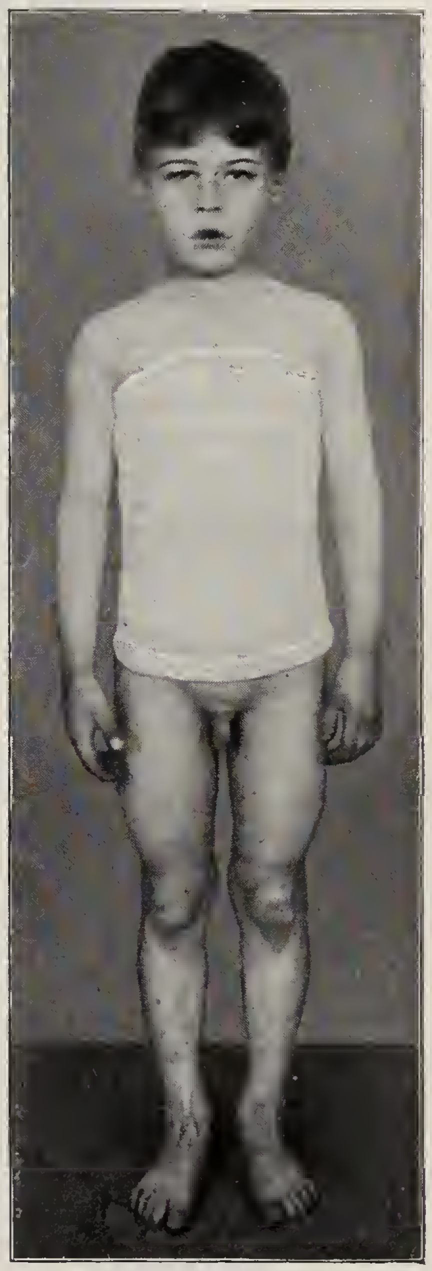

FIG. 403.—JACKET FINISHED BY TRIMMING AWAY HAMMOCK AND TURNING UP AND SECURING ITS EDGES.

The plaster-of-Paris jacket is applied either while the patient is suspended or while he is lying in a hammock. A seamless knitted shirt of wool is placed next to the skin, with layers of wadding or lamb's wool to protect bony prominences from undue pressure. The rolls of plaster-of-Paris bandage wetted in weak alum water are circularly applied in successive layers, reaching from below the line of both iliac crests upward to the axillae. Strips of the bandage should be curved upward behind and in front to gain additional support. Vertically applied strips either of pasteboard or of perforated tin are incorporated in the jacket between its layers to strengthen the apparatus. When the jacket is sufficiently hardened, the patient is lowered and the upper edge at the axillae trimmed so as to prevent excoriations. If the hammock is used (Fig. 401), it should be made of crossbarred crinoline or twilled Canton flannel, and the portion beneath the jacket allowed to remain *in situ,* the edges above and below the jacket being trimmed down and secured by a few additional turns of a bandage (Fig. 403). The jacket is to be renewed sufficiently often to insure cleanliness and prevent ulceration at prominent points. It has been suggested that the jacket be cut open in front and secured by lacing; this, however, lessens the efficiency of the apparatus.

Poroplastic felt corsets have been employed, particularly in Germany. Models of different sizes and shapes, representing the more common forms of the disease at different periods of life, are made, and on these a poroplastic material, the basis of which is woolen fiber and gum shellac dissolved in alcohol, is molded in the shape of a cuirass. When needed, one of these is selected, softened by heating, and applied to the patient while suspended, burning of the skin being prevented by first enveloping the trunk in an accurately applied wetted muslin bandage. The corset is secured in position by turns of a roller until it cools, when it may be removed, its edges lined with chamois leather to prevent chafing, and eyelet holes or shoe hooks placed in position for lacing.

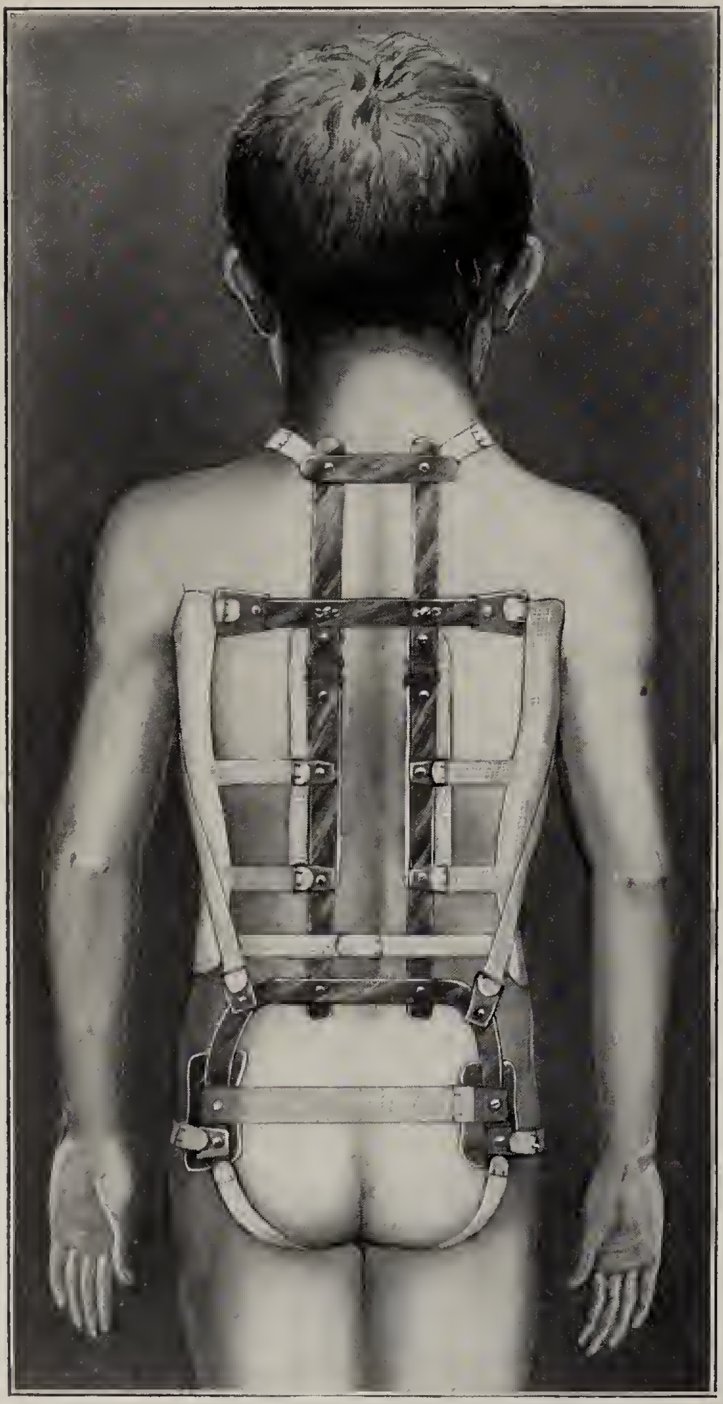

Fig. 404.—Taylor's Brace for Pott's Disease.

The **indications** governing the surgeon's choice in the use of these systems of support will depend on the location of the disease. In Pott's disease high up in the dorsal region, the plaster-of-Paris jacket or the poroplastic felt corset answers the purpose. In the middle and lower dorsal, as well as in the lumbar region, the Taylor type of support will be preferable. Care should be taken that the appliance is kept properly adjusted and renewed as the child outgrows it. The poroplastic corset is also employed after the plaster-of-Paris jacket during convalescence (Golding Bird).

These supports permit the patient to walk about. In case he is compelled to maintain the recumbent position for any length of time, or for night use, an apparatus designed for this purpose may be used (Schapps, Fig. 405). Extension may be applied by means of a weight and pulley (Fig. 381). The latter is more frequently used for Pott's disease in the cervical region.

The **constitutional treatment** includes medicinal and dietetic measures and fresh air. Patients should be kept out of doors as much as possible. Iron, cod-liver oil, and the most easily digested as well as the most nourishing food should be given. Much will depend on the healthful character of the patient's surroundings.

Forcible Correction of the Deformity in Pott's Disease.—Hippocrates (400 B. C.), Galen (A. D. 130–200), and Ambroise Paré (1517–1590) employed the method of extension, combined with direct pressure, for forcible correction of spinal deformity. This method was revived by Chipault (1895) and Calot (1896). In favorable cases a certain amount of repair takes place in the cavity left in the opening of the angle by the correction of the deformity. In cases in which the tuberculous process is still active, however, the reparative material will become infected and a mass of tuberculous granulations fill the cavity, the deformity recurring.

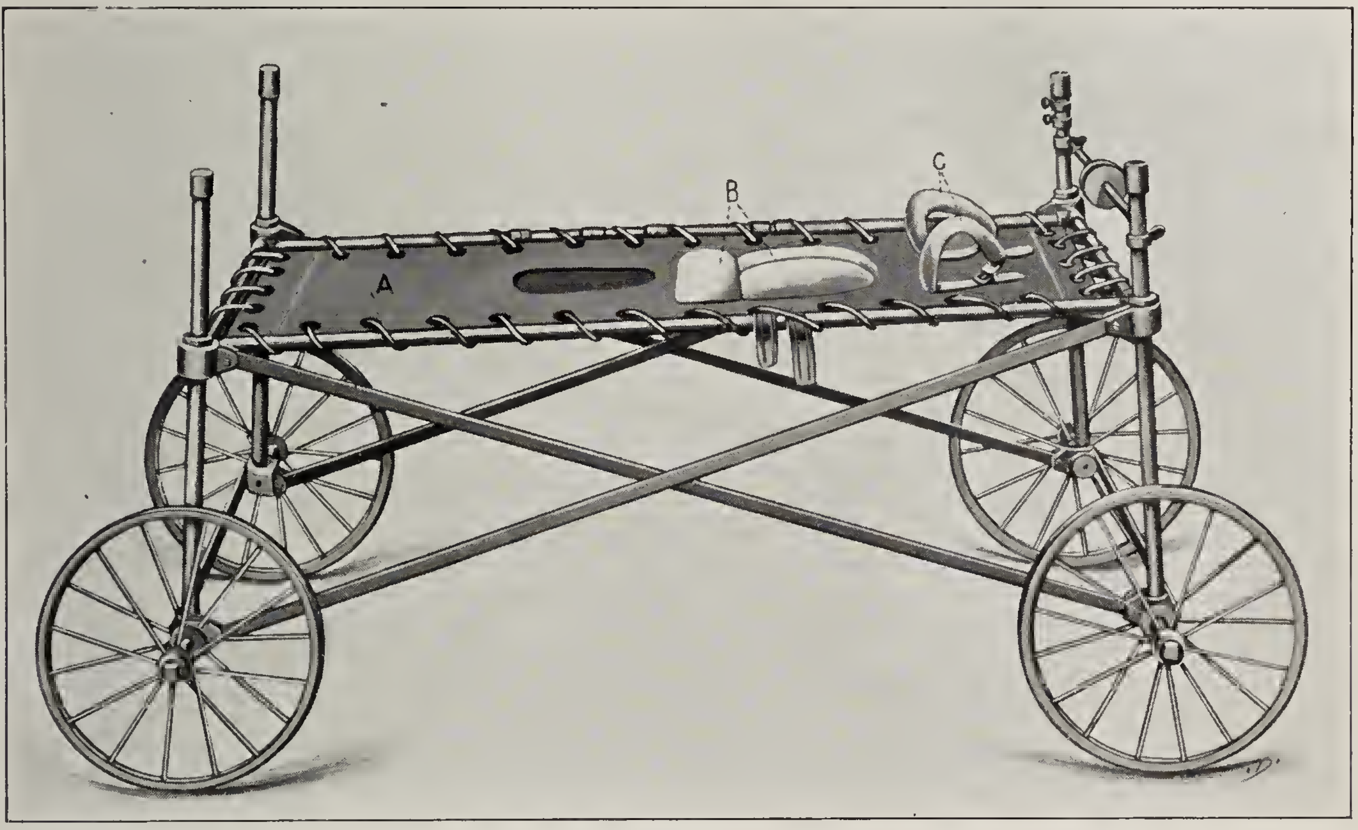

Fig. 405.—Schapps's Recumbent Apparatus for the Treatment of Pott's Disease.

A, Stretched canvas laced to the frame by stout cords; B, cushions stuffed with hair between which the bony projection rests; C, padded straps of webbing arranged to pass around the shoulders and through the axillae.

In Calot's method the patient is anesthetized, placed face downward, and traction applied on the head and shoulders in one direction and on the legs and pelvis in the other. When necessary, direct pressure is applied to the hump, the hand of an assistant, by pressing from the abdominal side, regulating the effect produced. The gastrointestinal canal should be empty. The same object may be attained with the patient lying on the back, direct pressure being obtained by the surgeon's hands placed beneath the most prominent part of the kyphosis and lifting the latter forward (J. Jackson Clarke).

Mechanic devices have been employed to lessen the number of assistants. The one consisting of a simple oblong frame with extension screws at both extremities and a double bridge on which the transverse processes in the vicinity of the kyphosis rest, is the best (Goldthwait, Fig. 406). With this apparatus the spine is placed in an overextended position, in some instances no other force than the weight of the body being required to accomplish the object. Anesthesia may sometimes be dispensed with, as, for instance, in cases of only one or two years' duration. The after-treatment consists in the application of a plaster-of-Paris cuirass, including in this the pelvis, dorsal and lumbar regions, and the head, with a small window over the point of greatest deformity.

It has been estimated that a traction of 220 kilos is required to dislocate the neck of a child of two and a half years. The 80 kilos traction usually recommended as the maximum is therefore well within the bounds of safety. Where the spines and laminae are fused together (**synostosis**), as in old healed cases, Calot chisels the laminae apart before completing the operation.

The Operative Treatment of Pott's Disease.—Surgical opinions differ as to the desirability of the early opening of abscesses of spinal origin. Owing to the difficulties of keeping the cavity of the abscess from becoming infected after incision and drainage, most surgeons prefer to defer this as long as possible unless some present or threatening complication demands it. Rupture of the suppurating focus into the pleural or abdominal cavities is of such rare occurrence and perforation of the spinal canal such a remote danger, that this delay seems to be justifiable.

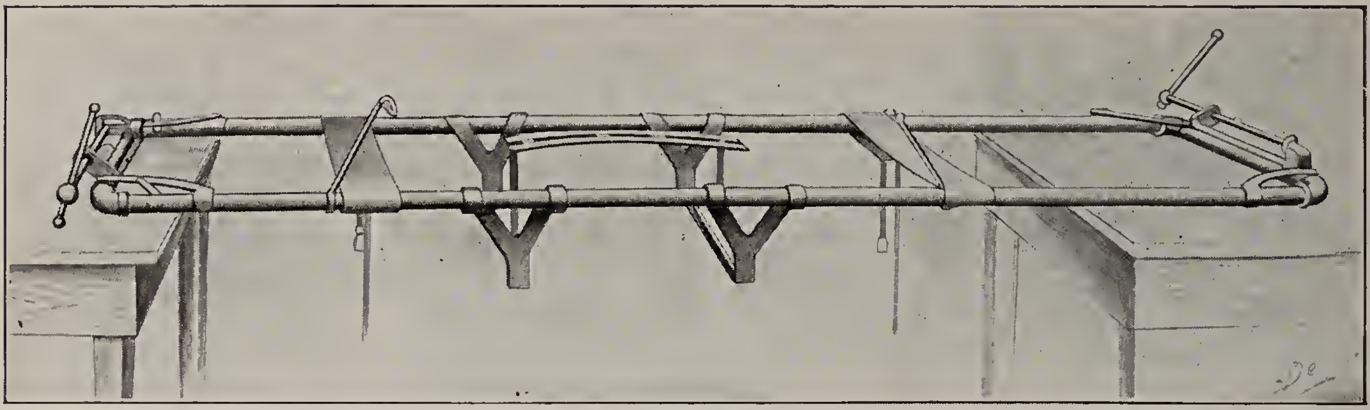

Fig. 406.—Goldthwait's Apparatus for Straightening the Spine.

When the abscess approaches the surface, **aseptic aspiration** may be practised to relieve the pressure and prevent ulceration of the skin and rupture. The latter is to be avoided, if possible, for the reason that it may occur at a time when infection cannot be prevented. The needle should be passed in an oblique direction in order to avoid passing it through the infected skin, in which situation the puncture may refuse to heal. **Overdistention** of the abscess cavity by antiseptic solutions has not thus far been followed by very encouraging results.

Once the overlying skin has become involved in the inflammatory process, however, spontaneous rupture is only a question of time, and **incision, antiseptic irrigation,** and **drainage** should be performed in order to forestall this untoward event. If methodic antiseptic irrigation, with gradual shortening of the drainage-tube and frequent dressing with copious masses of antiseptic gauze can be carried out, the intraabdominal pressure may lead to obliteration of the abscess cavity and final healing may take place in favorable cases.

Treves's Operation for Caries of the Spine.—The field of this operation is generally limited to the lumbar and lower dorsal vertebrae. The incision, as a rule, is made in the right loin. The patient is placed on the side with his knees drawn up and a sand-bag placed under the opposite side to render the field of operation more prominent. An incision extending from the last rib to the crest of the ilium is made at the outer border of the mass of muscles representing the erector spinae. The lumbar fascia is at once exposed and opened, the erector spinae muscle retracted, and its posterior sheath incised. The quadratus lumborum is divided to gain room and the anterior layer of the lumbar fascia opened to the extent of the external incision. Loose pieces of bone are sought for and removed and all accessible cavities scraped with a sharp spoon, irrigated with corrosive sublimate solution, and scoured with iodoform gauze. A large tube is placed in position and the remainder of the wound cavity packed with iodoform gauze. The wound is only partially sutured and is dressed antiseptically. The dressings are changed as soon as soiled externally by the discharges, antiseptic irrigation being practised at each dressing.

SPINA BIFIDA (HYDRORRACHIS)

The chief congenital deformity of the spine occurs as a cystic formation arising from the spinal medulla and passing out through a fissure of the vertebral arches. The fissure is the result of an arrest of development of the laminae of one or more of the segments of the spinal column. Where the spinal defect exists alone, it is known as spina bifida occulta. In the other varieties the condition is analogous to hernia, the sac with its contents being placed beneath the dorsal skin (*vide infra*).

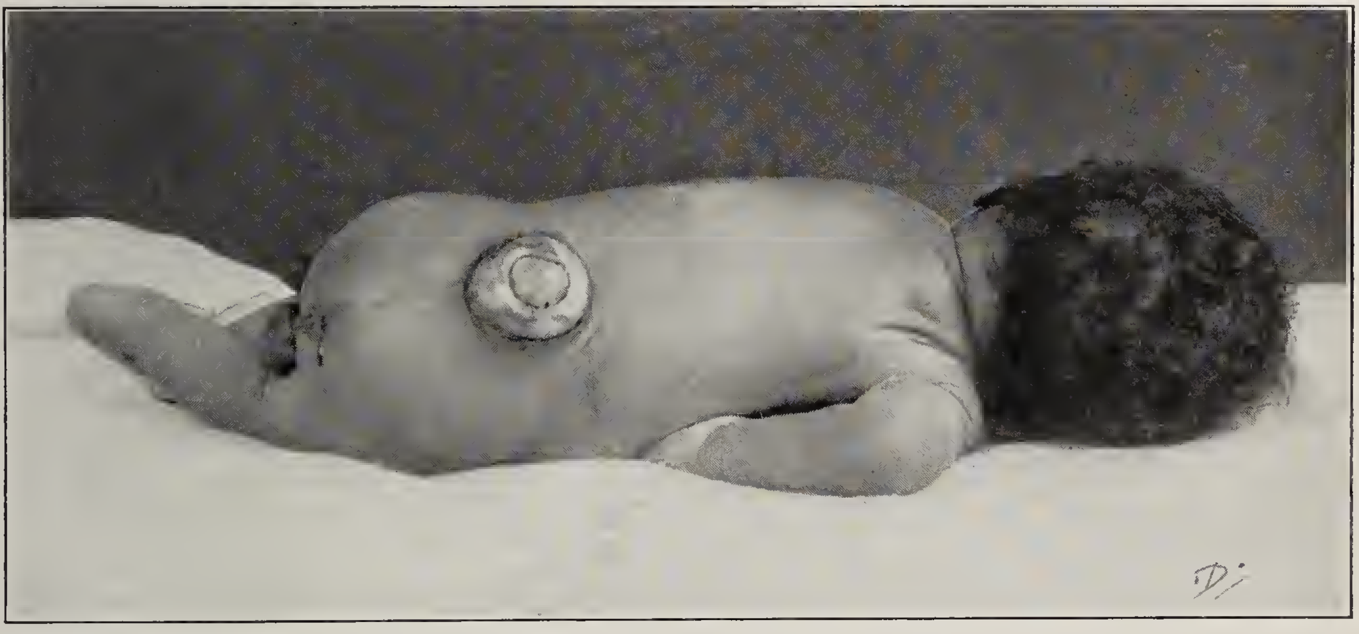

Fig. 407.—Spina Bifida with Ulceration.

The cyst is situated in the median line, and varies in size from a hazelnut to an orange. It is circular or slightly elongated vertically at its base and forms a flat globular prominence with occasionally a depression at the vertex (Fig. 407). It is most frequently found in the lumbar region, and is sometimes associated with encephalocele, clubfoot, and other deformities. In large tumors the skin is thinned, the clear fluid contents rendering the tumor translucent. The cyst cavity usually communicates with the central spinal canal and, through this, with the ventricles of the brain. When situated in the lumbar region it marks the termination of the canal in the cauda equina. The nerve-trunks of the latter are generally spread out and attached to the cyst wall.

Pressure on the tumor frequently causes elevation of the scalp over the anterior fontanel, a feeling of fluctuation on palpation being thus communicated from the head through the whole length of the trunk to the cyst. Occasionally the communication extends only to the subarachnoid space. When the cyst consists only of membranes and fluid, it is called a **spinal meningocele**; when in addition it contains a portion of the cord, it is called a **meningomyelocele.** Dilatation of the central canal of the cord is called **syringomyelia** or **myelocele.** Chemic analysis of the fluid shows it to be identical in composition with the cerebrospinal fluid, containing sugar and a small amount of albumin.

The function of the nerves may at first be wholly preserved in spina bifida. With increase of the fluid contents, however, paralysis of the lower extremity and the pelvic organs occurs from pressure. If the fluid is forced through the spinal canal from external pressure on the tumor, general convulsions may occur. When the child cries, the increase of venous intracranial pressure from increased tension of the tumor is observed.

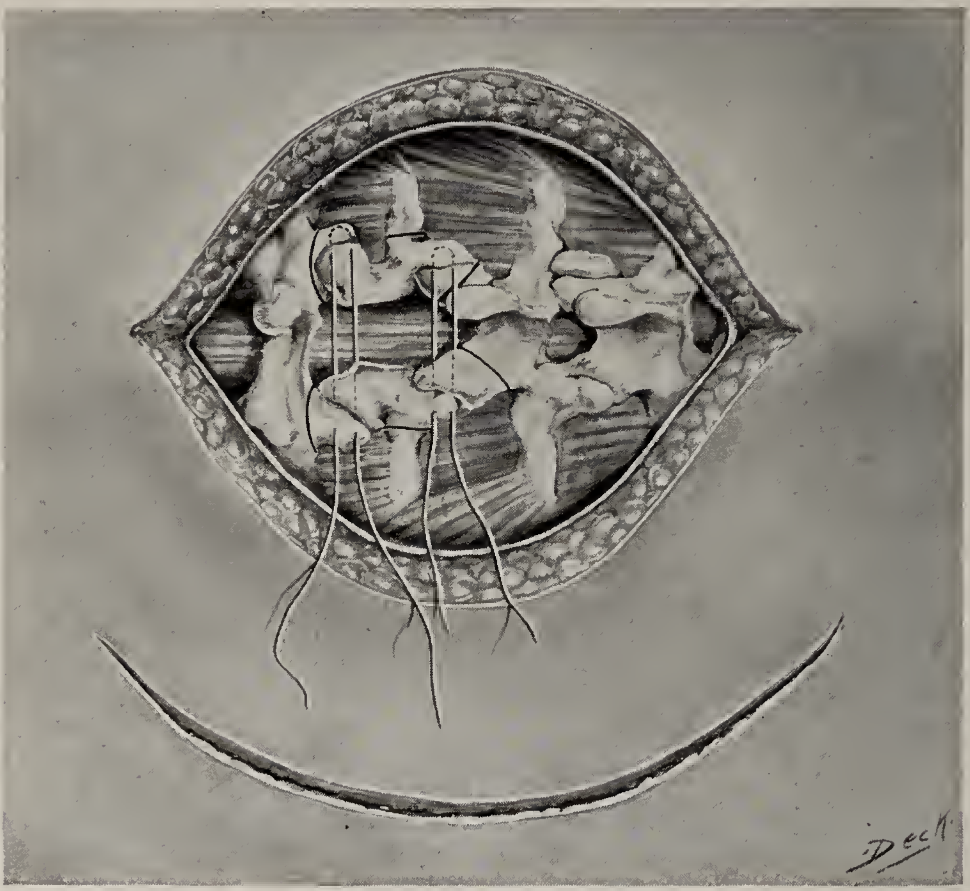

Fig. 408.—Spina Bifida.

Osteoplastic closure of the defect. Silver-wire mattress sutures applied. The solid black lines show the points of section of the bone (semidiagrammatic).

An overgrowth of hair in the surrounding skin (hypertrichosis) is a more or less striking feature of all clefts of the vertebrae. It is specially marked in cases of spina bifida occulta.

Spontaneous cure of spina bifida is rare. With constant increase of the fluid the overlying skin ulcerates (Fig. 407) and rupture takes place. The fluid escapes and death follows from septic inflammation of the interior of the sac and rapid extension to the spinal cord.

Treatment.—This should consist at first of measures to protect the skin covering and thus prevent ulceration, with the hope of the rare chance of spontaneous cure. With increase of tension or the supervention of paralytic symptoms, the question of operative interference must be considered. The method of injection consists of the introduction, under chloroform, of a needle attached to a syringe through the healthy skin at the basal periphery, the drawing off of about a dram of the fluid, and the injecting of an equal quantity of an iodized glycerin solution (iodin, 10 grains; iodid of potassium, 1 dram; glycerin, 1 ounce; Morton). This is left in the cyst. The wound of puncture is immediately sealed with iodoform collodion to prevent leakage of cere-

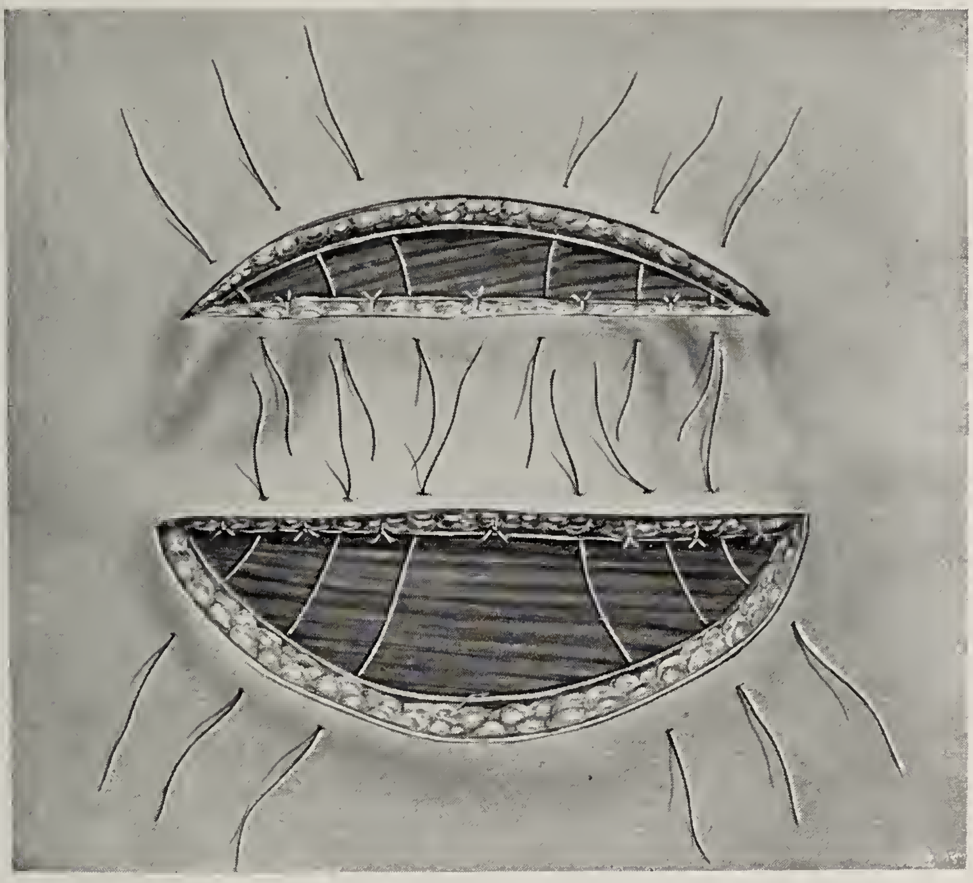

Fig. 409.—Spina Bifida.
Transplantation of a lateral skin flap to cover the site of the osteoplastic closure of the defect.

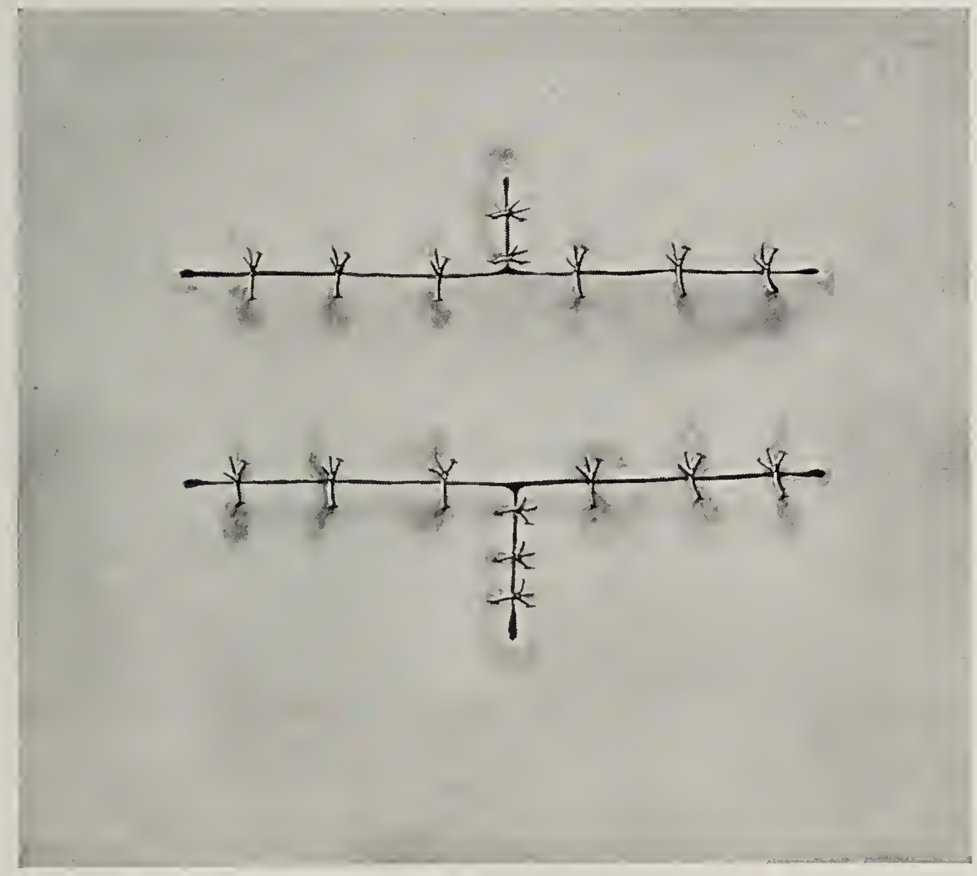

Fig. 410.—Spina Bifida.
The skin flap sutured in position and the lateral skin defects closed.

brospinal fluid and covered with aseptic gauze. If necessary, the injection may be repeated at intervals of from a week to ten days.

Radical operation is advisable in the majority of cases. Two lateral flaps are formed from the overlying skin and dissected down to the base, and the membranous sac carefully opened. The cauda equina, which is usually flattened out on the posterior wall of the sac, is cautiously detached and replaced in the spinal canal. The sac of the meningocele is then removed and the lateral flaps of the dura sewed together with fine catgut. The muscles and skin are then brought together and sutured separately by means of layer sutures. The suture line of the meninges and that of the overlying structures should not be immediately one above the other (Robson). The meninges may be sutured longitudinally and the skin transversely (Mikulicz). Where the spina bifida is covered with a thin layer of skin, a skin flap must be made from the surrounding region.

Filling in the gap between the edges of the congenital fissure with transplanted bone (Dollinger) may prove successful in cases in which some portions of the arches exist. In a case in my service at the Brooklyn Hospital I succeeded in carrying out Dollinger's suggestion by fracturing the rudimentary arches, forcing these together in the median line, and securing them in position by buried through-and-through silver wire mattress sutures (Fig. 408). A lateral flap with double pedicle was then transplanted centrally to cover the site of the defect, and sutured with catgut. The remaining portion of the flap was closed by transverse suturing (Figs. 409 and 410).

Where the osteoplastic method cannot be carried out, Bayer's method is the best. Two lateral flaps are made out of fascia and muscle. These are reversed in such a way that their dorsal surfaces lie anterior, and are covered with skin.

LATERAL CURVATURE OF THE SPINE (SCOLIOSIS)

Simple Scoliosis.—A lateral deviation of the spinal column is said to occur in infants from the nurse's habit of carrying the child on the left arm, its right shoulder leaning against the right shoulder of the nurse, a position which causes the spine to collapse (Werner, Schildbach). The left-sided simple or **total scoliosis** thus initiated may persist in weak subjects. Cases of right convex simple scoliosis are very rare.

Composite Scoliosis.—This is the variety most commonly observed. It is almost exclusively right-sided (this referring to the convex side) and the primary curve generally occurs in the dorsal region. The affection is more frequently observed in females than in males, the ratio being ten to one. The occurrence of a primary right convex curve in the middle dorsal region is thought to originate from a physiologic or rudimentary right-sided scoliosis arising from the use of the right arm in lifting, the strong muscles of the neck drawing the cervical vertebrae in the opposite direction in order to preserve the equilibrium and afford a support for the muscles of the right arm and scapula. This compensating cervical curve is often followed by a similar deviation in the lumbar region, these **compensating curves** being rendered necessary in order to equalize the force exerted in carrying the weight of the trunk and head in standing and walking. The greater mobility of the lumbar vertebrae frequently causes the compensatory curve in this region to become more pronounced than the original dorsal curve. In addition to the variety of scoliosis just described, an additional curve is sometimes observed, the right convex dorsal curvature being combined with a left convex lumbar and cervical curvature.

The occasional early occurrence of the left-sided lumbar curvature and its decided predominance over the dorsal, suggest this as the primary curve, developing from an original simple left-sided total scoliosis of infancy; the dorsal curve thus becomes the compensating curve.

As additional predisposing causes of the deformity may be mentioned the following: weak muscles and ligaments, the habitual assumption of strained and unnatural attitudes (writing at school), unequal length of the legs, and paralysis of one leg. It is most liable to arise at the age of puberty. It is also thought to be hereditary in some instances.

Rotation of the vertebrae on the longitudinal axis accompanies lateral curvature. The vertebral body always turns to the convex and the spinal processes to the concave side. In the common form of composite right-sided scoliosis the bodies of the dorsal vertebrae are rotated toward the right side and the lumbar toward the left side, the arches and spinous processes rotating in the opposite direction. The spine as a whole represents a spiral. The normal curves of the spinal column are altered, being either increased or diminished. **Asymmetry of the thorax, shoulder, scapula, and hip** follows the rotation of the vertebrae. The shoulder on the side of the convexity is elevated and the scapula projects; the opposite hip is raised. The entire thorax is displaced from right to left. The occurrence of the affection in the growing age, when the bones are soft and the muscles weak, tends greatly to make the deformity a more or less permanent one.

Symptoms and Diagnosis.—The deformity generally develops very slowly; exceptionally, it reaches a high degree in a few months. The attention of the patient or friends is usually first attracted by the asymmetry of the chest, shoulder, and hip. When a dress is being fitted it will be noticed that one shoulder droops, a shoulder-blade projects, or one hip is elevated above the other. A history of pain in the dorsal and lumbar region, increased by walking and sitting long in one position, and weakness in the back, may be obtained. The gait is observed to be awkward. In addition to the above, examination will disclose an elevation of the scapula, a lessening of the curve of the ribs on one side and an increase on the other, loss of the normal prominence of one iliac crest and an exaggeration of that of the other, a protuberant abdomen, and one breast more prominent and placed on a lower plane than the other; there is also a greater prominence of the erector spinae muscle on one side. The curves become prominent upon marking the tips of the spinous process with ink or an anilin pencil. Vigorous friction with the tips of the fingers along the spine will bring out a red line of congestion of the skin corresponding to the curves. Tenderness may be developed on pressing the spine.

Complications.—The deformity exercises more or less **restriction of the breathing capacity** and patients are unable to perform heavy manual labor. The occurrence of bronchitis or pneumonia is of more serious import, on account of the greater difficulty of getting rid of accumulated secretion by coughing. Defective respiration may lead to impaired circulation, in consequence of which the right ventricle becomes dilated and troublesome **palpitation of the heart** occurs. Disturbances of the nerve structures issuing from the vertebral canal may be observed. A certain amount of **oblique narrowing of the pelvis** occurs in high grades of the affection; hence, scoliotic women, in case of pregnancy, are liable to experience a difficult labor.

Prognosis.—The development of the deformity ceases, as a rule, at the end of the period of growth, or about the twenty-second year of life. At this time also the results of treatment are practically *nil.* If treatment is begun early in the case and an absence of osseous deformity can be demonstrated by the correction of the scoliosis by suspension, the prognosis is good for arrest of the affection and perhaps for complete cure. In cases of moderate osseous deformity arrest and possibly modification of the latter, and at all events improvement of the pains, may be hoped for.

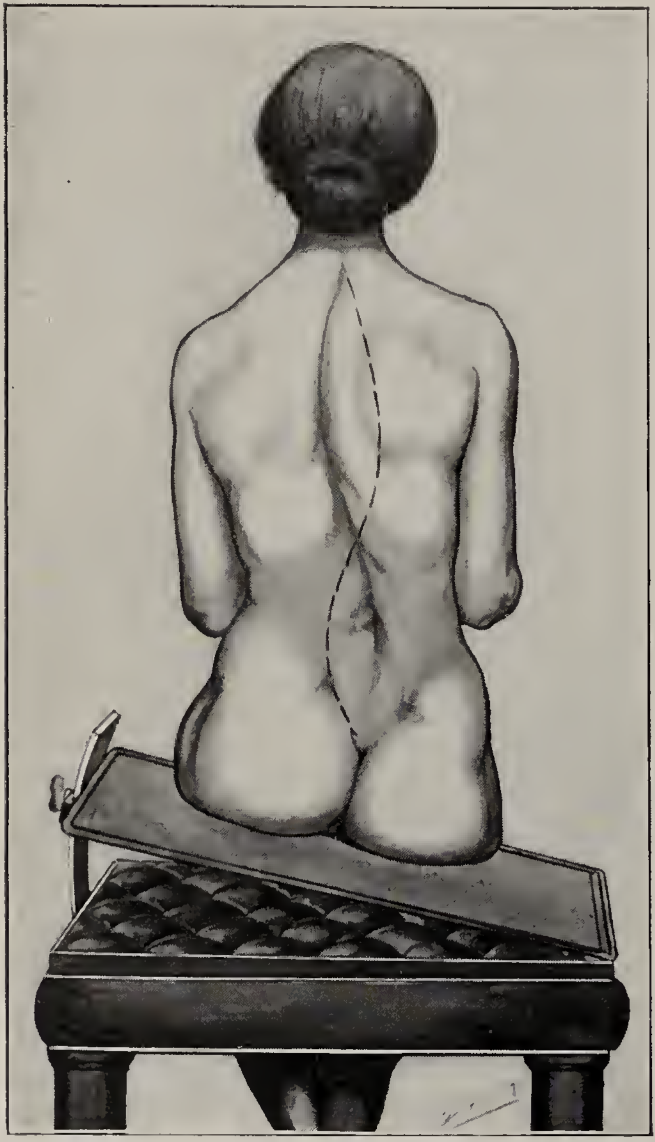
FIG. 411.—VOLKMANN'S WEDGED-SHAPED SEAT FOR CORRECTING THE LUMBAR CURVE.

After the cure of suppurative pleuritis, and particularly after resection of the ribs, the resulting deformity of the chest wall gives rise to lateral curvature of the spine (**cicatricial scoliosis**). This effect is produced by the cicatricial contraction of one side of the thorax.

The Treatment of Scoliosis.—**Prophylactic treatment** is embraced in the care of the general health, the correction of anemic conditions, the selection of proper chairs and writing-desks, and the furnishing of sufficient and properly directed light while at work in school. Finally, a watchful care must be exercised to prevent parents from sacrificing the health of the child to excessive mental culture.

General Measures of Treatment.—The cause should be removed where it can be ascertained. The extremities should be equalized by wearing a high shoe; change of occupation and methods of recreation are to be insisted on and a proper sitting position, or attitude, while standing and walking is to be advised. The general health should be carefully inquired into, and remedies administered that are calculated to correct any existing constitutional vice and restore the health and strength, such as cod-liver oil, preparations of iron, iodin, and the phosphates.

Correction of the Deformity.—The most important means at our command for this purpose are embraced in properly directed **gymnastic exercises.** The results of treatment will depend largely on how thoroughly the patient appreciates the importance of this part of the treatment and how persistently she devotes herself to the task of carrying it out. The system known as the Swedish, when the exercises are administered by a person thoroughly familiar with the method as taught in Sweden, is by far the best. In addition to these dumb-bell exercises or self-suspension by Sayre's apparatus (Fig. 400) should be practised, or the horizontal bar should be used several times a day; the patient should lie down for a short time after each séance. In all exercises the hand on the concave side should be kept on a higher level than its fellow. While the patient is sitting a Volkmann's wedge-shaped cushion (Fig. 411) is used to correct the deformity. When the patient is lying on his back, a hard pillow should be placed beneath the convexity. The Sayre head-piece for self-correction is very useful.

In the intervals of exercise and recumbency a Shaffer modified brace (Young) may be worn as a slight support and, in addition, as a reminder to the patient of the necessity of assuming an upright position (Fig. 412). The object of this apparatus and its modifications is not to correct the deformity by attempting to force the parts into a correct position. If worn constantly for this purpose and to the exclusion of other measures, it will certainly be productive of harm by restraining the action and development of muscular structures already weakened.

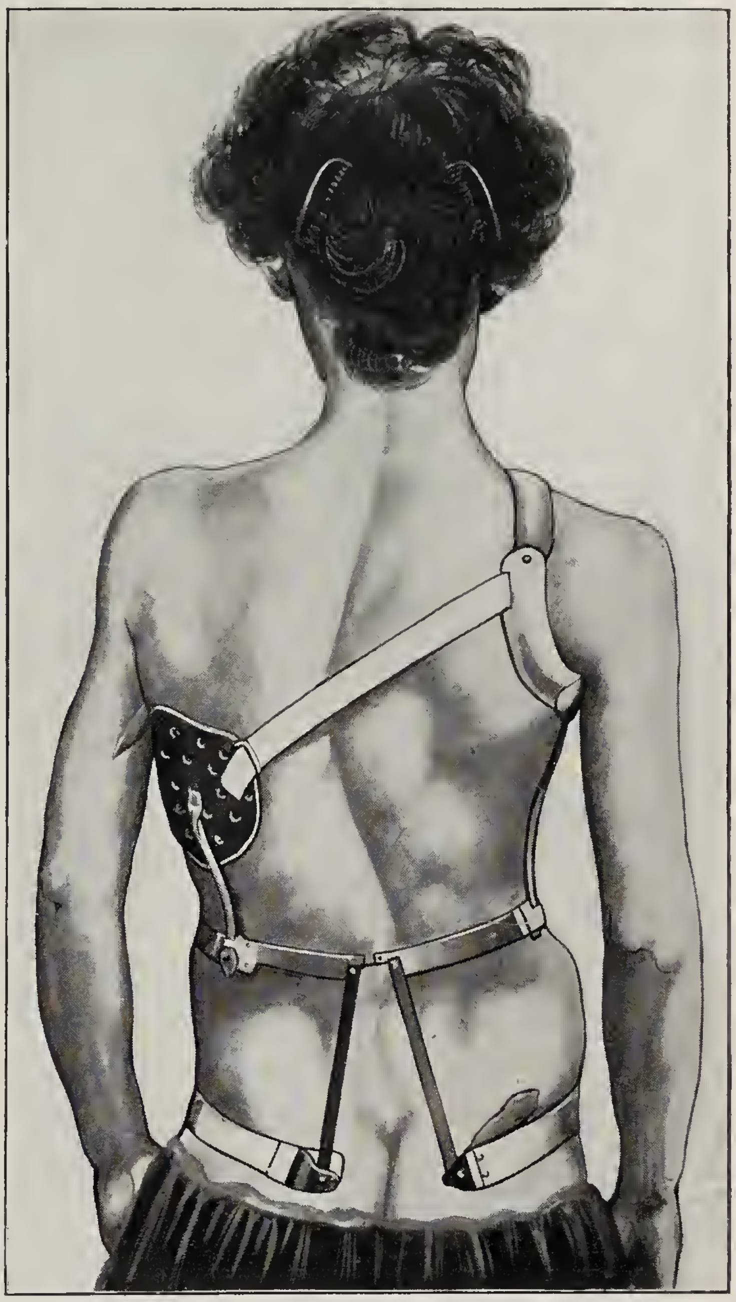

Fig. 412.—Shaffer's Brace Applied.

Jaboulay has suggested an operation for correcting the scoliosis by separating the ribs from the sternum and permitting the former to glide over the latter. For instance, in case of a scoliotic thorax the oblique diameter of which is lengthened from behind forward and from right to left, and shortened in the opposite direction, a separation of the right ribs at the sternum would cause the ends of the latter to project forward and inward. The transverse processes of the dorsal vertebrae would be thereby drawn anteriorly and the primary vertebral curves corrected by a rotating movement on the costal tubercle.

NONCARIOUS KYPHOSIS (SENILE KYPHOSIS)

This is the common round shoulders of old age. Partial absorption of the intervertebral discs takes place as a part of the general wasting process, and a corresponding increase of the upper dorsal curve occurs.

Round shoulders of rapidly growing children is another variety of kyphosis. It occurs in the upper dorsal region and results from a relative muscular weakness which permits the head to bend forward.

Habitual or **occupation kyphosis** is observed in otherwise perfectly healthy individuals who follow an occupation or trade in which position predisposes to the deformity. In all three of these varieties of kyphosis the shoulder-blades are dropped forward from their normal position.

Rheumatoid arthritis gives rise to a kyphosis which is associated with a rigidity of the entire spinal column (**spondylitis deformans**). It may occur as a complication of arthritis deformans in other portions of the body or in connection with gonorrheal infection. In the **osteitis deformans** of Paget both the dorsal and the lumbar curve are greatly increased. The most prominent symptom of spondylitis deformans is stiffness of the spine as a whole. Pain may be absent. The curves are not affected by lying down. The course of the affection is essentially chronic. The prognosis is unfavorable and the treatment extremely unsatisfactory.

Rachitic kyphosis usually affects the dorsal region. More than one vertebra is involved; the curve is always rounded and generally disappears on lying down.

Paralytic kyphosis occurs in paralysis of the muscles of the back from infantile paralysis (poliomyelitis anterior) and pseudohypertrophic paralysis.

Treatment of Noncarious Kyphosis.—In the kyphosis due to muscular weakness the use of apparatus should be discarded, as far as possible, and light gymnastics, such as dumb-bell exercises or weight and pulley exercises, substituted, the patient lying on the back on a lounge with the head and upper extremities projecting beyond the end (Stillman).

In spondylitis deformans the general measures useful in rheumatoid arthritis may be tried. Hot baths sometimes mitigate the symptoms. Pain on motion may indicate mechanic support. Attempts to ward off the ankylosis are useless and may be harmful.

In rachitic kyphosis the patient should be placed on antirachitic treatment (syrup of the iodid of iron, cod-liver oil, syrup of the lactophosphates of lime, tannin, etc.). The sitting position should be avoided as much as possible. Light braces or corsets may be of use in arresting the tendency to increase of the curvature. These cannot be worn by infants. In the case of older children gymnastics should be employed.

THE SPINAL CORD

General Concussion of the Cord.—Cases to which this term can be properly applied must be exceedingly rare, owing to the protection afforded by the relatively large space in which the cord lies and the presence of the cerebrospinal fluid. The application of a force sufficient to produce extensive molecular disturbances of the cord without coincident and appreciable injury of its bony encasement is a practical impossibility. Localized disturbances involving the substance of the cord may result from forced alterations in the shape of the spinal column, fracture or dislocation not necessarily being involved (*vide infra*).

Contusion.—This is usually to be attributed to forcible movements of the spinal column embraced under the term "**sprain.**" While in the milder forms of the latter the muscles alone are involved (**traumatic lumbago**), in the more severe forms the injury is accompanied by symptoms of shock, the ligamentous structures are stretched and sometimes torn, leading to extradural hemorrhage resulting in temporary paraplegia; there is more or less pain, referred to the extremities of the injured nerves, and stiffness due to involuntary efforts on the part of the patient to immobilize the spine through the medium of its supporting muscles. In contusions of the cord, on the other hand, there is usually a history of extreme and forcible flexion of the vertebral column and distinct evidences of a pronounced injury of the cord, such as the presence of motor and sensory paralysis and diminished reflexes, followed by degenerative changes the result of acute myelitis.

In the differentiation of these lesser injuries of the spinal cord in many instances, time alone will serve to clear up the diagnosis. Extreme difficulty may be experienced in the beginning in excluding fracture without deformity. If the contusion is of but moderate severity, improvement will be manifest in the course of a week or two. Extensive hemorrhage into the cord, however, may require as many months before the symptoms disappear. The damage inflicted, where the gray matter of the cord is extensively involved in the hematomyelia, may lead to permanent secondary degenerative changes. Or, without well-defined and even organic appreciable lesions discoverable clinically or at the autopsy table, so-called **traumatic hysteria** may develop. Among the symptoms of the latter are to be mentioned epileptiform convulsions, mental disturbances of hysteric origin, paralyses with contractures of the extremities, functional disturbances of the larynx, bladder, etc., these constituting a train of psychic phenomena peculiar to this condition. In addition to these, there may be sensory disturbances, such as anesthesia, hyperesthesia, or paresthesia; disturbances of function of nerves of special sense; or, finally, symptoms of vasomotor, trophic, or secretory nerve origin. In fact, there is scarcely a symptom known in neurologic science that may not manifest itself at some time or other as the result of autosuggestion in this class of cases (Charcot).

Compression of the Cord.—This is usually the result of hemorrhage sufficient to produce pressure on the cord after injury (**hematomyelia**). The term should be restricted to those instances in which the symptoms due to the presence of the blood predominate and evidences of pronounced injury of the cord are absent. The hemorrhage may proceed from the vessels of the cord itself or from those between the membranes and the cord (**intramedullary hemorrhage**), the soft vascular gray substance suffering most (**central hematomyelia**). Or, the hemorrhage may proceed from the plexus of veins lying between the dura and the walls of the spinal canal (**extradural hemorrhage**). In the intradural variety there may be but a single point of hemorrhage or a number of small hemorrhages. In either case the effusion of blood may extend into the gray substance (**tubular hemorrhage**).

The exact nature of the traumatism producing the hemorrhage is not well understood. In the case of the newborn direct traction in forceps deliveries seems to account for it. It would appear, however, that stretching of the cord can scarcely occur in adults, except in connection with fracture or dislocation. Nevertheless the condition arises most frequently in connection with sudden movements of the spinal column, and in the most movable portions of the latter, *e. g.*, in the cervical region and in the lumbar enlargement. Its occurrence in the dorsal region is probably unknown. Extensive hemorrhages rarely occur after contusions.

Symptoms.—The occurrence of intramedullary hemorrhage is announced by the sudden appearance of symptoms of transverse injury of the cord, after injury not apparently involving the bony encasement of the latter. These include pain in the back due to injury of the posterior roots or posterior horns, disappearance of the corresponding reflexes, spasmodic contractions, rigidity, the rapid supervention of paralyses with early involvement of the lower bowel and bladder, bedsores, and the girdle symptom. It is difficult in the beginning to separate the symptoms due to pure compression from those due to coincidental destruction of nervous elements, since the former come on rapidly. The latter, however, persist and become permanent, while those due to simple pressure are in a great measure temporary and may disappear in a few days. Where the damage to the cord is due to the pressure of the extravasated blood, the symptoms will persist, as in the case of injury of the cord arising directly from the traumatism itself. The most prominent of the permanent symptoms arising from changes in the cord due to a central hematomyelia are alterations in the pain and temperature senses, and atrophy of the individual groups of paralyzed muscles. The symptoms may point to either a unilateral or a bilateral lesion.

Finally, the later symptoms following hemorrhage into the substance of the cord are in the main identical with those attributed to the peculiar cavity formation in that structure known as **syringomyelia.** This circumstance suggests that the latter condition may be due to localized softening following central hematomyelia of traumatic origin, the area of softening becoming filled with gliomatous tissue which later on undergoes cystic changes.

In extramedullary hemorrhage (**hematorrachis**) the effusion is within the vertebral canal. The symptomatology varies in its prominent features according to the extent of the hemorrhage. In typic cases there is present sudden and violent pain in the back, sensitiveness to pressure, radiating pains following the course of the nerves, the roots of which correspond to the area of the extravasation, and tingling sensations and hyperesthesia referred to the distribution of these nerves. There is rigidity of the affected section of the spinal column due to irritation of the nerves supplying the vertebral muscles, and sometimes spasm of the muscles supplied from below the seat of the hemorrhage. General convulsive movements have been observed. Retention of urine may occur. This, however, is liable to be spasmodic in character. Consecutive motor disturbances do not, as a rule, amount to complete paralysis.

In the differential diagnosis of hemorrhage within the substance of the cord and hemorrhage into the vertebral canal difficulties may arise from the fact that the two conditions may coexist. It may be stated in a general way, however, that in the last named the symptoms of irritation (pain, hyperesthesia, and spasm) are the most prominent and occur early, and the paralysis is quite commonly incomplete and later in development. On the other hand, in intramedullary hemorrhage the paralytic symptoms are usually pronounced and occur early, while those of irritation are less pronounced or entirely wanting.

The **prognosis** will depend on the extent and location of the lesion. In cases in which the hemorrhage is limited, particularly those occurring in the lumbar region, the prognosis is more favorable. Intramedullary hemorrhage in the cervical region always involves a grave prognosis, both immediate and remote. With early and complete paralysis, incontinence of feces and urine, and the occurrence of bedsores, a rapidly fatal course is to be expected.

Treatment.—In mild or doubtful cases the treatment resolves itself into perfect rest in the recumbent position. In well-marked cases of hemorrhage within the vertebral canal with rapidly developing paralysis and threatened involvement of important centers, laminectomy (see page 2), with removal of the compressing clot, is justifiable. The same may be said of cases in which, after the lapse of several weeks, symptoms of spinal hemorrhage following an injury persist without improvement.

When compression of the cord arises from the presence of **tuberculous caries of the vertebrae** the condition present is due to a peripachymeningitis with consequent proliferative processes and myelitis. As a rule, the latter is not tuberculous. The compression is rarely attributable to displacement of the vertebrae, nor yet to the presence of large masses of inflammatory new formation tissue. The characteristic symptoms are those of slowly increasing compression, such as progressive weakness, until complete paralysis finally ensues, and neuralgic pains arising from involvement of the nerve-roots. The latter symptom is not, as a rule, of long duration. Comparatively slight injuries may give rise to the symptoms, which, in the case of the upper cervical region, may prove rapidly fatal. The paralysis, when advanced, involves the rectum and bladder. It may be symmetric, asymmetric, or, in rare cases, unilateral.

Rest in the recumbent position and the internal use of potassium iodid are sometimes of service in the paralysis of Pott's disease (Gibney).

Tumor pressure may arise from neoplasms originating in the vertebrae or occurring as metastatic deposits, from those springing primarily from the membranes and affecting the cord secondarily, or from true intramedullary tumors. Vertebral tumors are usually malignant in character, and root symptoms, such as excruciating neuralgic pains, hyperesthesia and paresthesia, trophic disturbances, motor irritation (spasms and contractions), etc., predominate. Later on the symptoms are practically identical with those of **pressure paralysis.**

Intravertebral tumors comprise those which are primarily extradural (lipoma, sarcoma, chondroma, and echinococcus cysts), intradural growths or those which occur between the dura and the pia (fibroma, lipoma, angioma, psammoma, neuroma, and neurofibroma), and intramedullary tumors (glioma, sarcoma, gumma, and cysts). Carcinoma and sarcoma may also occur as metastatic deposits. Sarcoma may occur as pure sarcoma, or as fibrosarcoma or myxosarcoma. Gummas and sarcoma appear, as a rule, first in the pia, and secondarily involve the cord. Finally, intradural growths may spring from individual nerve-roots.

Malignant tumors of extradural origin occur with greater frequency in the lumbar and cervical regions than in the dorsal vertebrae. The bodies of the vertebrae are attacked and the growth generally progresses in an anterior direction. They are more common in females than in males and are usually secondary to malignant disease of the breast. They are characterized by excruciating pain in the course of the nerves, and extreme tenderness, the pains being greatly increased by movements. **Lipomas** sometimes attain a large size and occasionally spring from the subdural adipose tissue. They may be mistaken, on superficial examination, for spina bifida. **Fibromas** spring from the periosteal connective tissue, generally in the neighborhood of the spinous processes of the lumbar vertebrae. Osteomalike bony proliferations are observed in arthritis deformans.

Intradural tumors (lipomas, sarcomas, and echinococci) may give rise to pain and spasm from irritation, generally without motor or sensory impairment, as the most prominent symptoms. Myxomas, fibromas, sarcomas, and psammomas produce violent pains by pressure on the medulla, tonic and clonic convulsions, and finally paralysis. Among other symptoms distinguishing intradural tumors from inflammatory or other changes in the spinal cord may be noted the gradual onset of the pain, an irregularly unilateral course of the symptoms, neuralgic shooting pains, anesthesia and pain ascending from the soles of the feet, and dull pain in a circumscribed portion of the spine. The reflexes may be exaggerated at first; they are finally lost altogether. Rigidity of the spinal column and tenderness on percussion are found to exist later in the case.

Intramedullary tumors possess but slight interest to the surgeon, since they are not amenable to surgical treatment. Their consideration belongs to the domain of the neurologist.

Treatment of Spinal Tumors.—Nonmalignant extradural growths may be removed by operation, the latter being conducted in accordance with indications arising from the situation and size of the growth.

Cases of focal spinal lesion thought to be dependent on tumors of intradural origin have been deemed fit subjects for operative interference since the publication of Victor Horsley's celebrated case (1887). This surgeon successfully removed an almond-sized fibromyxoma which had developed at the roots of the third and fourth dorsal nerves and compressed the cord. The operation is practically identical with that described as laminectomy (see page 2).

Wounds of the spinal cord are of infrequent occurrence. Knife and bayonet wounds occur most frequently in the neck, particularly in the exposed region between the occiput and the atlas, and the atlas and the axis. Next in frequency stab wounds occur in the upper portion of the thorax and in a direction from below upward. The lumbar region usually escapes.

In **gunshot wounds** of the cord the latter may be injured by the ball, by fragments of bone driven into the canal by the missile, or by both. The missile may pass through from side to side, cutting away a portion of the cord. Under these circumstances fragments of bone driven ahead of the ball or carried with it are likely to inflict damage on the remainder of the cord. Usually, however, the ball lodges in the spinal canal.

The **symptoms** of wounds of the cord vary with the extent of the division. In cases in which the cord is transversely divided, or nearly so, there is immediate paralysis of the parts below the injury and collapse of the individual. Wounds of the upper segment are quite uniformly fatal; in the cervical region above the fourth cervical vertebra death usually takes place almost immediately. Septic infection is not of frequent occurrence. Escape of cerebrospinal fluid is not commonly observed.

Prognosis.—The immediate prognosis depends on the location of the injury. The usual absence of suppuration greatly improves the prospects of recovery from the immediate effects of the injury itself, as far as danger to life is concerned. The ultimate prognosis, or that which relates to recovery from the resulting interference with the function of the cord, will depend on the extent of the damage inflicted.

Treatment.—Formerly this comprised attention to the wound. In stab wounds this limitation still holds good. In gunshot wounds, however, the spinal canal may be exposed (see Laminectomy, page 2), the missile and any splinters of bone present removed, and an attempt made to repair the damage to the cord. This will consist of trimming away contused portions of the damaged structures and suturing the cord with chromicized catgut (Stewart and Harte). In Stewart and Harte's case, that of gunshot injury of the cord in the lower dorsal region, this was so far successful as to permit the patient to get about quite comfortably with the aid of artificial support. A similar case came under my care at the Brooklyn Hospital, in which, although the patient was able to maintain the erect position for a few moments, and to make spasmodic efforts at locomotion with the aid of artificial support, in other respects at the end of two years he was practically helpless.* A notable feature in my own case was the prompt healing, after the suturing of the cord, of an extensive ulceration in the sacral region, which had rapidly supervened during the first few days after the injury. In spite of the apparently favorable outcome of the first-mentioned case, regeneration of the cord after its complete severance is not to be expected, however promptly the divided structure is sutured.

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SECTION XVIII

THE SURGERY OF THE ABDOMINAL AND PELVIC REGIONS

THE ABDOMINAL WALLS

Injuries of the Abdominal Walls.—**Contusions of the abdominal walls** possess an importance apart from the dangers to the underlying viscera, on account of the free hemorrhage which sometimes occurs in the intermuscular planes. In case the extravasation is in the properitoneal connective tissue it may spread extensively by gravitation; it is characterized by discoloration resulting from chemic changes in the coloring-matter of the blood.

Punctured, incised, and glancing wounds of the abdominal walls are rarely followed by serious hemorrhage. The larger vessels (the superficial and deep epigastric and the branches of the lumbar arteries) are rarely injured. In case of injury to one of these vessels the external wound should be enlarged, if necessary, and the vessel ligated.

In case of **gunshot wounds** the ball will sometimes pass along one of the musculo-aponeurotic planes of the abdominal walls without entering the abdominal cavity.

Injury of the peritoneum frequently complicates wounds of the abdominal walls. Peritonitis and extrusion of portions of the greater omentum and intestinal loops through the wound may occur. Every effort must be made to differentiate **nonpenetrating** and **penetrating** wounds of the abdominal walls. A careful exploration of the injured parts must be made, the original wound track being followed until the character of the latter in this respect is cleared up. In view of the importance of an exact diagnosis, in doubtful cases the surgeon is justified in enlarging the wound under an anesthetic, in order to ascertain the exact condition of the peritoneum.

Rupture of the muscles of the anterior abdominal wall from muscular contraction is sometimes observed. The recti muscles are usually involved. The accident occurs most frequently in typhoid patients. Muscular changes due to infection predispose to this rupture. Alcoholism also predisposes to it. Nussbaum saw two cases in which the accident happened during coitus. It may happen during labor. It has been observed in tetanus. In a case under my own observation rupture of the right rectus muscle by muscular effort in bowling, in a drunken man who did not know he was injured until some hours afterward, led to the diagnosis of appendicitis. Masses of coagulated blood are felt in the abdominal wall lying transversely to the point of rupture. The latter cannot, as a rule, be made out until after resorption of the effused blood. Healing usually takes place, a muscle callus or cicatrix forming. Suppuration may take place, particularly in typhoid cases. Rupture of other muscles may take place by extreme overexertion, particularly of the longissimus dorsi; such, for instance, as sometimes occurs in lifting heavy weights.

Inflammations of the Abdominal Walls.—Primary suppurative inflammations of the abdominal walls are very rare, except those which follow wounds of the skin and muscles. Those which occur secondarily are as follows:

1. **Migrating abscesses** from tuberculous osteomyelitis of the lower dorsal or upper lumbar vertebrae. These invade the layers of the abdominal muscles at the posterior edge of the quadratus lumborum. They may reach the linea alba, but usually open on the anterolateral surface of the abdominal wall.

2. **Migrating iliopsoas abscesses** reaching Poupart's ligament and attacking the layers of the abdominal wall just above the ligament and at its external side, between the anterior superior spinous process of the ilium and the epigastric artery.

3. **Abscesses Arising from Inflammation of the Vermiform Appendix.**—These occur almost exclusively on the right side. They tend to point in the neighborhood of the umbilicus.

4. **Abscesses Resulting from Suppurative Lymphadenitis.**—These may have their origin either in the superficial inguinal glands or in the deeply placed iliac glands. In either case the abdominal wall in the neighborhood of Poupart's ligament is involved.

5. **Abscesses Originating in the Connective Tissue of the Lesser Pelvis.**—Here the suppuration ascends subperitoneally to the fascia transversalis and appears at Poupart's ligament near its internal portion. These abscesses may continue unrecognized, however, until they finally make their way in the direction of the anterior superior spine.

6. **Abscesses Originating in the Renal Pelvis (Suppurative Pyelitis).**—These may appear at the lower edge of the twelfth rib on the posterior abdominal wall or they may make their way along the ureter in a downward direction until they reach the anterior edge of the quadratus lumborum, finally appearing at the anterior superior spinous process of the ilium.

7. **Abscesses Arising from Suppurative Hepatitis.**—Abscesses originating from **echinococcus cysts of the liver** are also to be mentioned in this connection. The right side of the abdominal wall is most frequently affected in this class, though the left hypochondriac region may be involved in cases in which the left lobe of the liver is the seat of the original suppuration. Abscesses of hepatic origin involving the abdominal wall are usually distinguished from those of renal origin, for which they are most likely to be mistaken, by the fact that the former rise and fall with the respiratory movements.

8. **Abscesses Originating in the Spleen.**—These arise almost exclusively from suppurating echinococcus cysts and are situated in the left hypochondrium.

9. **Abscesses of Gastric and Intestinal Origin.**—These may have their origin in foreign bodies in the stomach and intestinal canal, and in ulcerative processes apart from these. The location of these abscesses varies greatly, for the reason that they may originate from any portion of the gastro-intestinal tract.

10. **Suppurative Changes Resulting from the Breaking Down of Blood-clot after Hemorrhage in the Anterior Abdominal Wall.**—These are sequels of the contusions and muscular ruptures previously alluded to.

11. There are a small number of abscesses of the abdominal walls of uncertain origin, the so-called **idiopathic abscesses.** They develop in the subperitoneal connective tissue. The fact that they give out a strong fecal odor when incised suggests an intestinal origin.

Phlebitis of the umbilic vein in the newborn arises from infection that has its origin in decomposition of the remains of the umbilic cord. The infection may be conveyed to the liver by means of infective thrombi, causing abscess of the liver. The preventive treatment consists in thorough cleansing of the parts and the use of antiseptic dressings on the stump of the cord.

Tumors of the Abdominal Walls.—**Atheromas** are very rare, owing to comparative absence of hair and sebaceous follicles. **Lipomas** are somewhat common, and should not be confused with hernial protrusions of the greater omentum. The latter occur at the usual openings in the muscular wall of the abdomen where hernias make their exit, while the former may occur at any portion of the abdominal wall. In making the differential diagnosis the following points are to be borne in mind: A lipoma may always be lifted somewhat from the muscular abdominal coverings; in epiplocele the pedicle-like extension of the tumor can be felt passing into the hernial opening. Lateral mobility of a lipoma is pronounced, while this is slight in epiplocele. Generally a portion of the epiplocele may be reduced. The dangers of an error in diagnosis, in the event of extirpation, are obvious, and in doubtful cases should impel the surgeon to operate with caution, as for an epiplocele.

Still greater difficulties are encountered in differentiating between a **retroperitoneal** or a **subperitoneal lipoma** and an epiplocele. These lipomatous masses arise in the connective tissue between the peritoneum and the fascia transversalis, and sometimes follow the route of a true hernia to the surface, and may even lead to the occurrence of the latter, as is shown by the frequency with which a hernial sac is found lying behind a lipoma in the operation for the extirpation of the latter. The error under these circumstances is not a grave one, since the resemblance to hernia is so close that the operation is usually undertaken in the belief that a hernia is to be dealt with and necessary precautions are taken.

Fibromas and **sarcomas** are sometimes observed in the abdominal walls. A form of **myxosarcoma** has been described as having a special tendency to occur in the muscular abdominal wall. I have met with two such cases. When **carcinoma** is present, it is usually a direct extension of a similar condition within the abdomen. It seldom finds its way to the surface except at the site of the cicatrix surrounding an artificial anus established for the relief of obstruction of the bowel due to the disease. Malignant disease of the omentum, by fusing with the abdominal wall, may be mistaken for tumors of the latter. Malignant tumors of the abdominal walls almost always involve the peritoneum, and hence great difficulties are encountered in closing the defect following their extirpation. This may, however, be sometimes accomplished by careful suturing and plastic replacement.

As the necrotic stump of the umbilic cord separates in the newborn, granulation occurs, followed by cicatricial contraction, the so-called umbilic cicatrix. These granulations are sometimes replaced by the formation of **umbilic granulomas.** These are small, bright red tumors, varying in size from a pea to a cherry. They are easily removed by the scissors.

Myxomas of the umbilic cicatrix in infants are large and soft tumors, having their origin in the remains of the mucous tissue in the umbilic cord which escape destruction in the necrotic process. **Papillomas** are sometimes observed in the same situation. Fibromas, sarcomas, and carcinomas are very rare in this locality.

The omphalomesenteric duct sometimes persists and forms a tumor at the umbilicus. It appears as a dark blue convolution covered with mucous membrane similar to that of the intestinal canal, with which it is biologically identical. This mucous membrane forms a prolapse in the umbilic ring analogous to prolapse of the rectal mucous membrane at the anal opening. Glands identical with those of the intestinal mucous membrane were demonstrated in a case by C. Hueter. Extirpation under proper precautions to prevent the occurrence of peritonitis should be performed.

Incomplete obliteration of the urachus gives rise to two surgical affections at the umbilicus. These are the following: (1) **Cysts of the urachus** arising from retention of secretion, this becoming inspissated and producing more or less irritation. The inspissated collection is sometimes forced in wormlike masses from the duct still patent at its upper end. These cysts may sometimes attain a considerable size, as observed by Roser. (2) **Urachal fistulas,** the urine being forced into the lower end of the urachus, where the latter communicates with the bladder. When the bladder becomes overdistended, the urine finds its way to the umbilicus, which presents a bulging appearance at first. Perforation at this point finally occurs and the urine escapes in drops.

Urachal cysts are best treated by incision and drainage, or by extirpation, though in a case under my care the opening at the umbilicus permitted cleansing by hydrogen dioxid after evacuation and gave no further trouble. Urachal fistulas usually heal spontaneously when the obstruction to normal urination is removed.

THE ABDOMINAL CAVITY

Contusions and Ruptured Wounds of the Abdominal Organs.—The elasticity of the abdominal walls, the mobility and want of resistance of the contained viscera, suspended as they are for the most part by duplications of the peritoneum, and, finally, the protection afforded by the elastic lower portion of the thoracic wall, particularly to the liver and spleen—all these circumstances combine to prevent the abdominal organs from being easily injured by blunt force. Those that are most firmly anchored rupture first, such as the kidney; the liver follows next in frequency, and last the spleen.

The only unyielding point against which a blunt force may compress the abdominal contents, and thus produce rupture, is the spinal column. If, for instance, a wheel passes transversely over the anterior abdominal wall, rupture from compression may take place in the manner above indicated. Compression of the vena cava against the lumbar spine by such an accident may produce dilatation of the vessels of the head and neck, with hemorrhage in the conjunctival tissue (Hueter). **Contusion** of the **sympathetic solar plexus** may produce **cardiac paralysis** by a blow on the epigastrium.

Wounds of the abdominal organs may occur from contusions as well as from projectiles and stabs. The first danger in these cases is hemorrhage. In the absence of an external wound this is diagnosed by the pallor, weak pulse, thirst, air hunger, etc. These symptoms sometimes develop rapidly; in other cases they occur slowly, this depending on the size of the vessel or vessels involved. **Rupture of the aorta and inferior vena cava** prove rapidly fatal; next come the large vessels of the kidneys, liver, and spleen. Parenchymatous hemorrhage from these latter organs is not so rapidly fatal, and that from the renal tissue is least dangerous of all. The latter is rather common and is recognized by the presence of blood in the urine. **Hematuria** is not necessarily a sign of renal hemorrhage. It may be due to contusions of the ureters, bladder, or urethra, and these sources must be excluded in the diagnosis. Blood-clots descending from the pelvis of the kidney assume the shape of casts of the ureters. These hemorrhages from the kidney usually take a favorable course, the blood gradually disappearing from the urine. Unless infection from the urine occurs the contused portion of the kidney heals without suppuration. The contused tissue is finally replaced by cicatricial tissue. Suppuration of the contused renal tissue may be a part of a general pyemic condition the result of coincident injuries.

Maas collected 71 cases of severe renal contusions in which there were 37 recoveries, 11 deaths due to hemorrhage, 3 to suppuration of the renal tissue, and 2 to suppression and uremia from contusion of the only kidney present, the other being congenitally absent. In the remainder of the cases death took place from causes independent of the renal injury. While **nephrectomy** is not necessarily to be resorted to for renal hemorrhage, since spontaneous arrest may occur, even if a large branch of the renal artery is injured, it is to be recommended in cases of suppuration of the renal tissue.

Hemorrhage from rupture of the liver and spleen is particularly menacing to life, especially in the case of the liver, in which death is more frequently due to hemorrhage than to subsequent hepatic abscess. Of 267 cases of injury of the liver collected by L. Mayer, 135 were contused wounds, of which 117 ended fatally. Out of 61 cases of rupture of the spleen, 55 ended fatally.

Abdominal section, or **laparotomy,** is always indicated in intra-abdominal hemorrhage, whatever its source, provided only the patient's condition will permit it. In ruptures of the liver and spleen the application of a ligature to isolated bleeding points, even if these could be identified, is exceedingly difficult; the application of the thermocautery and tamponade with iodoform gauze is the indicated procedure in the majority of cases. In isolated instances the application of a circumsuture has been successfully carried out, but the friable nature of the tissues dealt with will permit this only rarely. Firm packing with iodoform gauze, however, is frequently successful, the end of the strip being led out of the abdominal wound.

ABDOMINAL SECTION

The Operation of Abdominal Section (Celiotomy, or Laparotomy).—The position of the patient may be the horizontal dorsal, or the dorsal combined with elevation of the pelvis, the body being kept from sliding by a cross-bar made to fit the shoulders (Trendelenburg).

The Incision.—This is usually made in the median line between the umbilicus and the pubis. The abdominal wall is made somewhat tense by the thumb and middle finger of the operator's left hand. With a small scalpel an incision of the required length is made through the skin. For aseptic reasons, the scalpel is now changed for another, the fat layer incised, and the sheath of one of the recti muscles laid bare. This is cut somewhat obliquely for a short distance and the exact location of the linea alba ascertained. Or, the incision may be carried directly through the rectus muscle. The incision is then deepened, an assistant catching up the tissues with a dissecting forceps on one side while the operator steadies them with another pair of forceps on the other, and thus the dissection is carried on layer by layer until the peritoneum is reached. This structure is held well forward by plain dissecting forceps and a very small opening is made. This is enlarged without releasing the peritoneum until the index-finger of the left hand can be introduced. The further enlargement of the opening can now be made by the blunt scissors or knife, the operator using the finger as a guide, and being certain that neither loop of intestine nor omentum at the upper angle of the wound intervenes nor the bladder at the lower angle. One or two vessels may require clamping for a short time; these do not, as a rule, require ligation.

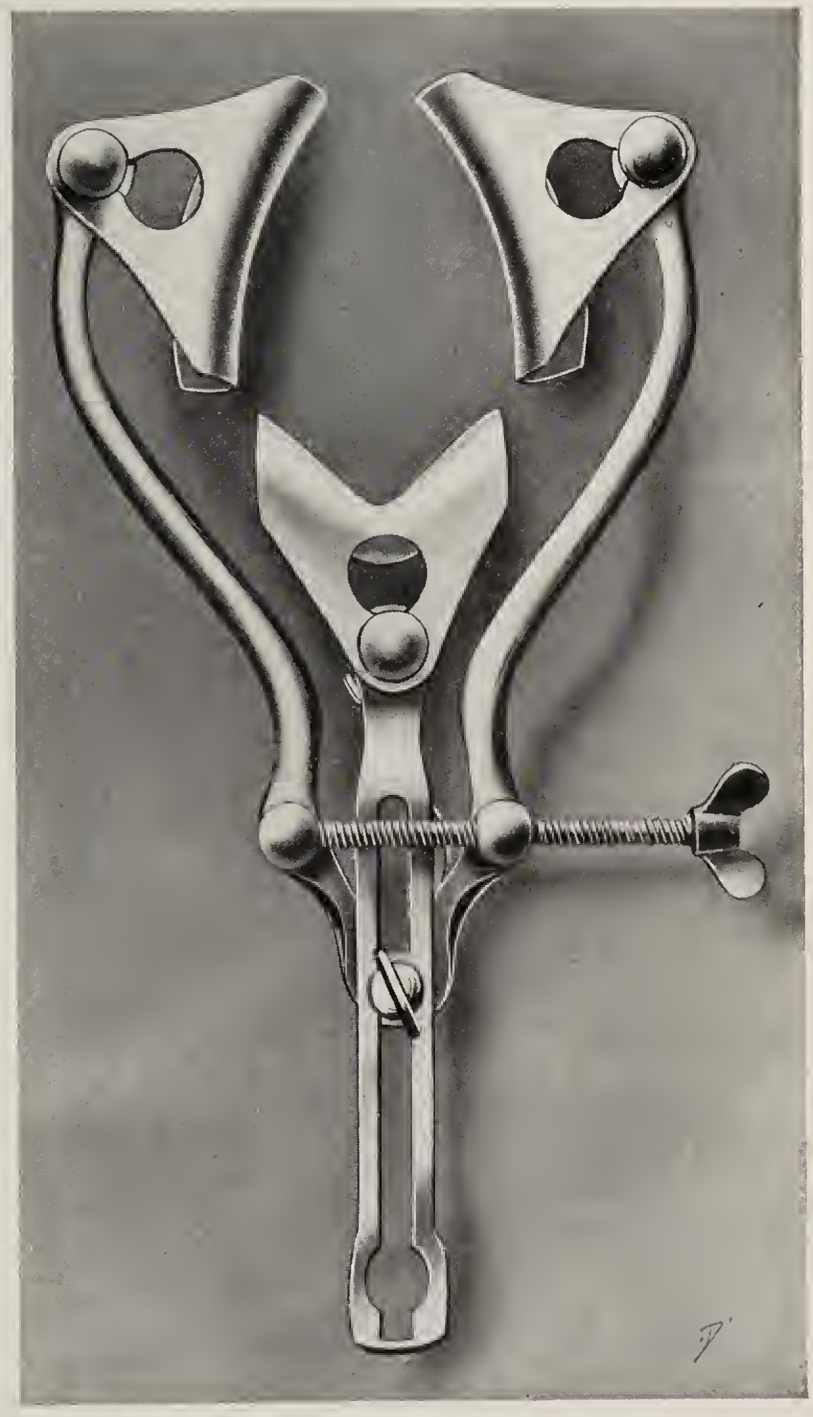
FIG. 413.—SELF-RETAINING ABDOMINAL RETRACTOR.

If it becomes necessary to prolong the incision during the operation, this may be done by means of the curved scissors. In carrying it above the umbilicus, the incision should be curved around the latter on the left side and then upward, in order to avoid the suspensory ligament of the liver. Under these circumstances, some operators prefer to excise the umbilicus.

Practically the same technic is employed in making the incision above the umbilicus. Other methods of gaining access to the abdominal cavity will be described in connection with their special indications.

Closing the Abdominal Wound.—The layer suture of absorbable material (catgut or kangaroo tendon) is most frequently employed, the peritoneum being first united by a continuous suture, the aponeurosis overlapped, and the skin edges approximated separately. Too early softening of these, however, may lead to the development of ventral hernia. It has been claimed (Richardson) that the original through-and-through abdominal interrupted suture serves every purpose. The removable layer suture combines the advantages of the layer suture with the through-and-through suture, effectually disposes of the "dead space" between the layers, and removes the pressure of the suture across the skin edge of the wound (see Vol. I, page 324).

The Post-operative Complications of Abdominal Section.—Of these, **peritonitis** is the most serious. It may be simply localized and hence conservative. It may extend beyond the field of operation, occupying a limited area, this, however, representing but a fractional portion of the entire peritoneal surface (**limited peritonitis**). This form of the disease is marked by comparatively mild symptoms and these mostly of a local character. Pain and tenderness are present within the area of inflammation; there is a limited amount of distention. The temperature is but slightly elevated and the pulse is only moderately accelerated. The inflammation may subside after giving the surgeon a day or two of anxiety, or it may extend to the still uninvaded peritoneum (**spreading peritonitis**) and may prove to be the precursor of the much dreaded **general septic peritonitis.** The serum of the peritoneum possesses the power, under certain conditions of peritoneal leukocytosis, of destroying the most virulent microorganisms. There is a limit to this power, however, and other measures of treatment must be instituted, such as salines promptly administered to eliminate septic material, enemas to forestall excessive distention and paralysis of peristalsis, together with the elevated head and trunk position to facilitate the passage of septic fluids into the pelvis (see Peritonitis, page 34).

Fecal Fistulas.—These may occur during the after-treatment in cases in which the integrity of the intestinal wall has been impaired by the inflammation (**gangrene of the intestine**), or when the conditions have been such as to prevent typic methods in dealing with the appendix in cases of appendicitis. Fistulas communicating with the large intestine, particularly those following appendicitis operations, frequently close spontaneously. In case they do not, Senn's method may be tried. This consists in first dissecting the orifice of the fistula from the skin and closing it with a temporary suture to prevent infection. The fistulous track is then freed from the abdominal parietes, the abdomen opened, and the site of the fistula turned in, together with the point of temporary suture by suturing the serous surfaces of the intestine over it. I have been compelled, in several instances, to perform **ileosigmoid anastomosis,** with **circumclusion** of the ileum by a loop of silk applied as a closely fitting but not constricting ligature between the point of anastomosis and the fecal fistula, before obtaining a successful result. The fecal fistula will then sometimes close spontaneously. If not, Senn's method may be applied with greater hope of success.

Thrombophlebitis of the veins of the lower extremity results from infection, enforced lying in bed and consequent blood stasis in poorly nourished patients, particularly those suffering from varices. Both lower extremities sometimes become involved. The limb may remain swollen for weeks. It occurs in about 2.5 per cent of all cases of abdominal section.

Ventral Hernia.—Improper suturing of the abdominal wound, septic conditions entering therein, the occurrence of meteorism during the first few days, and the necessity for drainage after an abdominal operation, lead to this complication. It is relatively frequent below the level of the umbilicus and is seldom seen above this point. There is stretching of the cicatricial tissue at the site of repair until this sometimes becomes so thin that the intestine can be felt through it. The key to successful operation in this class of cases consists in completely dissecting away every trace of cicatricial tissue by splitting the abdominal layers in the direction of their plane surfaces, and, with the peritoneum as a starting-point, in suturing each layer separately. This may be done with chromicized kangaroo tendon, or, better still, by the removable layer suture (see Vol. I, page 324).

The **wound complications** following abdominal section are such as are found elsewhere. Remote suppurative foci in the abdominal cavity developing after abdominal section for conditions originally infectious, such as appendicitis, require evacuation, the abdominal cavity being reopened for the purpose.

The After-treatment of Abdominal Section.—When no septic complications exist, the after-course of cases of abdominal section is almost uneventful, except in the unusual event of **post-operative intestinal obstruction,** which takes the shape, as a rule, of internal strangulation, or of angulation, most frequently the latter (see page 73). These complications should be promptly met by reopening the abdomen and relieving the obstruction.

For the purpose of favoring peristalsis and thereby relieving nausea and vomiting, as well as of facilitating the passage of fluids from the abdominal cavity to that of the pelvis, the patient should be placed in the **elevated head and trunk position** immediately on being returned to the bed. He may partake freely of water unless vomiting is persistent or intractable, and large enemas of decinormal saline solution are to be given. The ingestion of milk or other fluid diet may commence as soon as the stomach will bear it, the amount being increased from a half ounce in the commencement to full milk diet at the end of twenty-four or forty-eight hours at the latest. This should be rapidly supplemented by farinaceous food preparations and meat broths, and light but solid food at the end of a week. The rectal tube should be passed if flatulence is troublesome; distention must be carefully watched for and treated by enemas. The latter assist in controlling nausea and vomiting, and for this purpose **lavage,** followed by five grains of oxalate of cerium and one-fourth of a grain of muriate of cocain, is also useful. If the stomach is unable to retain nourishment, nutrient or stimulating enemas may be administered. Pain is to be controlled by hypodermic injections of small doses of sulfate of morphin. The bowels are to be moved on the fourth or at the beginning of the fifth day, except when the operation has involved the intestinal canal, in which case a day or two longer is advisable. Half grain doses of calomel every half hour for three hours, followed by a half ounce of sulfate of magnesium in Vichy, with cracked ice, are usually efficient. If this is not effectual at the end of three or four hours, dram doses of sulfate of magnesium should be given hourly, and an enema every two hours. (For the Treatment of Peritonitis, see page 38.)

The external dressings should be removed and replaced by others in accordance with the rules governing the treatment of wounds in general.

PENETRATING WOUNDS OF THE ABDOMINAL CAVITY, WITH PROLAPSE OF OMENTUM AND INTESTINE

In cases in which the wound of the abdominal wall is sufficiently large, the intra-abdominal pressure forces either the omentum or a loop of the intestine, or both, out of the wound. If the bowel is also injured, an additional complication is added (see page 58). In the present connection **simple prolapse** will be considered. If this is not promptly reduced, the amount of prolapsed bowel may rapidly increase, until a yard or more of small intestine is permitted to protrude by its comparatively long mesentery. Before reduction the prolapsed portion must be thoroughly irrigated with a 1 : 1000 warm sublimate solution, followed by a warm decinormal saline solution. Reduction is effected with the aseptically prepared finger. The dangers of infection are considerable in these cases and no precaution should be omitted.

If the wound in the abdominal wall is relatively small, the prolapsed intestine or omentum becomes rapidly strangulated. The return circulation is easily interfered with, while the arteries continue to force the blood into the prolapsed structures; the dark blue color of **venous congestion** results. This, together with serous transudation, leads to increase in the size of the prolapsed mass, and it becomes necessary to enlarge the wound before reduction can be accomplished. Delay in the reduction involves risk of gangrene, which, in its turn, leads to the formation of a **fecal fistula** or **artificial anus,** unless the gangrenous bowel is resected and the ends sutured. In many instances gangrene is followed by diffuse septic peritonitis and death results quickly. (For Resection of the Bowel and Enterorrhaphy, see page 60.) In the treatment of prolapsed omentum the latter should be drawn forward after the wound is enlarged, until a healthy portion is reached. The part to be removed is then isolated from the remainder of the omentum by a line of sutures, which is made to encroach upon the healthy portion sufficiently to permit at least half an inch to intervene between the two portions. The sutures are of the interrupted kind; each one includes about half an inch of omentum and is to be left long and tied as a ligature (Fig. 414). The gangrenous portion is cut away, some healthy omentum being included. The cut edge is now "rolled up," as it were, so as to bring its raw surface against the flat surface of the spread out omentum, where it is secured by a few sutures. This is designed to prevent adhesions between the raw edge and the neighboring intestinal coils, and the possible obstruction of the latter from angulation (see page 73). The stump is now thoroughly disinfected and placed in the abdominal cavity and the abdominal wound sutured. Silk or catgut should be employed for ligating the omentum.

Gunshot Wounds of the Abdominal Cavity.—About 3 per cent of all wounds received in battle involve the abdominal cavity, according to Nussbaum's studies, and the statistics of the American Civil War. Among the 3717 penetrating wounds of the Civil War about 0.8 per cent failed to injure the intestines. Since the introduction of the modern small bullet and high-velocity arm this proportion has been reduced. (For Injuries of the Stomach and Intestinal Canal, see page 58.)

The prognosis of **gunshot wounds of the kidneys** depends on whether or not the peritoneum is injured at the same time. In the former case the urine from the injured renal tissue will find its way into the peritoneal cavity and cause rapidly fatal acute peritonitis. The only safety lies in immediate nephrectomy. The exigencies of active military service scarcely ever permit this before extravasation of urine into the abdominal cavity occurs. If the peritoneum remains intact, while the dangers are still great the kidney may not be sufficiently damaged to demand removal at once, though it is good surgery to provide at once for the escape of urine, if this does not occur through the wound, by enlarging the latter, nephrectomy being performed ultimately. In case of extensive injury of the organ, however, with alarming hemorrhage indicating injury to a large vessel, nephrectomy should be performed.

Gunshot wounds of the spleen endanger life by the hemorrhage, which is very difficult to arrest and may prove rapidly fatal. Pain in the left shoulder in gunshot wounds of the abdomen is always suggestive of injury to the spleen. If the injured spleen is prolapsed through the wound, as in the case of injury from explosive projectiles or shells, this portion should be resected. Partial or complete removal of a prolapsed spleen, whether injured or not, affords a more favorable prognosis than does reposition. The mortality of injuries of the spleen is about 87 per cent.

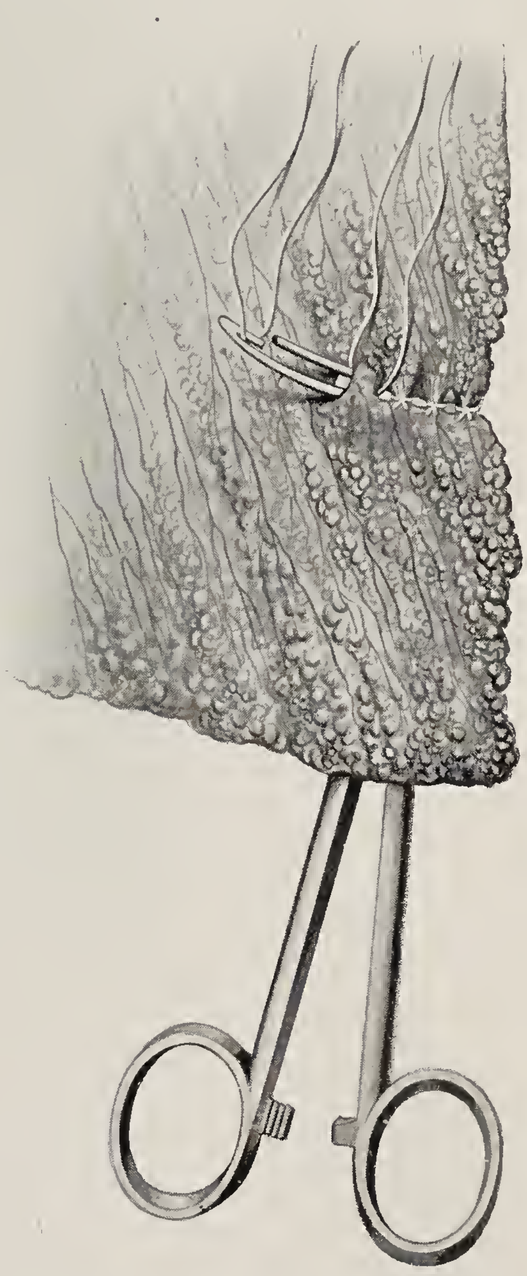

FIG. 414.—MULTIPLE LIGATION PRELIMINARY TO RESECTION OF OMENTUM.

In placing the first ligature one end of the latter is passed through the omentum near its border, and released. The carrier is then made to grasp another ligature and bring it through the same opening on withdrawal. The same end is then passed through the omentum a second time, about $\frac{3}{8}$ of an inch from the last opening, released, and another ligature grasped and drawn through by the carrier. This process is repeated until the entire width of the omentum is ligated. The first and last ligatures pass around the borders of the omentum.

In cases of **gunshot wounds of the liver** the dangers from the passage of bile into the abdominal cavity are to be considered. This may cause a fatal peritonitis, though 40 recoveries out of 61 gunshot wounds of the liver are reported by Mayer. The bile itself is not necessarily septic. Bostrom showed that large quantities of it may be rapidly removed from the abdominal cavity by absorption, its presence giving rise to no symptoms. In cases, however, in which the locality of the wound points to **injury of the gall-bladder,** the abdomen should be opened and the gall-bladder, if found to be injured, should be either sutured or removed. Even in gunshot wounds of the liver alone, the safer course is to perform an exploratory laparotomy, and, if nothing more can be done than simply to institute drainage, this has its advantages. I have followed this practice with very happy results. In case the bile appears externally a **biliary fistula** results; this frequently closes spontaneously. Suppuration occurs easily in the liver after injuries of this organ, and **abscess of the liver** not infrequently follows, with subsequent rupture into the abdominal cavity and resulting fatal peritonitis. Severe pain in the right shoulder is suggestive of injury of the liver. Hiccough, considered by some as an important symptom, is probably due to coincident injury of the diaphragm. **Icterus** is present in only about 9 per cent of the cases (24 out of 267 cases, Mayer).

Bullets penetrating the abdominal cavity may finally injure the **vertebrae** and **spinal cord.**

PERITONITIS

The peritoneum is an enormous lymph-sac and inflammation of this membrane is therefore a lymphangitis. The peritoneal absorbents are represented by lymphatics in the structure of the peritoneum. These lymph-channels are large and numerous in the neighborhood of the diaphragm, with comparatively large openings, or stomata; in the intestinal area the lymph-trunks and stomata are less numerous; while in the pelvic area the larger lymph-channels and stomata are absent.

Inflammation of the peritoneum is exclusively of septic origin and may be due to direct infection, *e. g.*, contact of the germ with the peritoneum, or to indirect infection from the presence of toxins which invade the peritoneum through the circulation. Inflammation of the peritoneum in the diaphragmatic area, other things being equal, is far more dangerous than that in the intestinal area, on account of the presence of the large absorbent trunks and the slowness with which these are sealed by infection and thrombo-lymphangitis. The next most dangerous area is the intestinal area, where the lymph-channels, though neither so large nor so numerous as in the region of the diaphragm, are still sufficient in size to permit absorption of septic material and its rapid dissemination in the system at large. In the pelvis the peritoneum is rich in capillary lymphatics, but the larger lymph-channels and stomata are absent (Byron Robinson). Hence, infection and inflammation of the lymphatics of the pelvic peritoneum quickly occlude the capillary lymphatics and absorption through these is prevented, the septic process remaining more distinctly localized; the peritoneum in the intestinal area, on the other hand, with its larger and less easily occluded lymph-channels, when inflamed, furnishes septic products which are quickly fed to the system at large, with the effect of producing death in many instances. A like result follows infection and inflammation of the diaphragmatic area, only with still more deadly rapidity.

Peritonitis may be divided into (1) perforative peritonitis; (2) infectious peritonitis; (3) symptomatic peritonitis; (4) tuberculous peritonitis; (5) peritonitis due to undetermined infection. (For a classification of peritonitis based on the extent of area involved, see page 30.)

Perforative Peritonitis.—In by far the greatest number of cases of this character the infection has its origin in the intestinal canal. This may occur through a demonstrable lesion in its walls, or the infection may pass through as a result of some disturbance of function of the latter due to disease or interference with the circulation. Acute appendicitis, typhoid ulceration, foreign bodies, penetrating wounds, and gangrenous conditions following intestinal obstruction are the most common causes of the lesions producing perforative peritonitis. Disturbances of function of the intestinal wall permitting infection to occur may be due to internal strangulation, strangulated hernia, intussusception, obstruction by twists, mesenteric embolism and thrombus, and to excessive handling of the intestines during abdominal section.

The microorganism most frequently found is the **Bacterium coli commune.** This constitutes about 95 per cent of the microorganisms found in the intestinal canal. Other microorganisms probably play a part in the production of peritonitis, but are not identified in the exudate for the reason that they are crowded out by the rapid growth of the common colon bacillus above mentioned.

Infectious Peritonitis.—Extension of infection from preexisting septic foci, within the abdominal cavity or immediately adjacent to the peritoneum, gives rise to infectious peritonitis. It may be due to rupture of abscesses, or inflammation having its origin in the genital tract. It may follow imperfect asepsis in abdominal section. The common pus microorganisms, viz., the streptococcus and staphylococcus, are present, most frequently the latter, associated with other microorganisms. The peritonitis resulting from the infection of the Streptococcus pyogenes develops quickly and is, as a rule, much more rapidly fatal than that due to the staphylococcus. The latter develops all grades of virulence, however, but this is mild, as a rule, as compared with that of the streptococcus. Infection of the peritoneum through the circulation may take place from the presence of a streptococcus inflammation in a remote portion of the body, *e. g.*, facial erysipelas.

Symptomatic Peritonitis.—This may occur in the course of an acute or of a chronic disease which itself depends on a specific germ, such as pneumonia and pleurisy. The pneumococcus is most frequently found. It may be present in the peritoneum in fatal cases of pneumonia without peritonitis, or it may be found in pure culture in cases of peritonitis occurring in the course of pneumonia or pleurisy.

Tuberculous Peritonitis.—This occasionally occurs as a primary disease. It is usually due, however, to extension of infection from tuberculous foci elsewhere, generally in the neighborhood, such as the intestines, the genital organs, particularly the reproductive organs in the female, and the retroperitoneal glands; it may follow tuberculous disease of the lungs and pleura. The **ascitic, fibrous,** and **ulcerative** forms are to be distinguished (Aldibert). In the first named the process is a subacute or a chronic one, few adhesions occur, the intestines float freely about in a clear ascitic fluid, and the peritoneum is the seat of small, scattered tubercles. It occurs rarely as an acute miliary tuberculosis of the peritoneum. In the fibrous form there may be little or no ascitic fluid present, and no adhesions, but large tubercles are found here and there on the peritoneal surface. In another variety of the fibrous form the coils of intestines are matted together in a mass of adhesions. In the ulcerative form the foci break down, and, later on, become the seat of suppurative changes.

In **peritonitis arising from undetermined causes** the infecting agent may be due to either syphilis, gonorrhea, or rheumatism. The peritonitis of fetal life, as well as that of the newborn, may also be included in this form of the disease, though in the case of the newborn it is not always possible to exclude infection from separation of the umbilic cord.

Symptoms and Course of Peritonitis.—The virulence of the infecting microorganism and the rapidity of the invasion of the peritoneum will govern largely the onset of the disease. In the perforative and infectious forms of the disease there is rapid dissemination of the septic material over the serous surface and a proportionate degree of **shock** and **collapse.** Slow extension from a small septic focus, on the other hand, is not attended by shock. The pain varies in severity with the virulence of the infection and the rapidity of its dissemination; in rare and inexplicable cases it is absent. The pain and tenderness may be general or localized. **Nausea and vomiting** are prominent symptoms, which follow rapidly on the onset of the disease. The vomited material consists first of the stomach contents; this is soon followed by bile and finally, in fatal cases, by the contents of the intestines. The latter are at last simply regurgitated. **Hemorrhage** from the gastric mucous membrane may occur, with dark brown vomitus (hematemesis). **Paralysis of peristalsis,** due to serous infiltration of the wall of the intestine and edema of the submucous connective tissue, occurs early, as a rule, in extensive and virulent infections, and is soon followed by symptoms of intestinal obstruction. The latter may enter largely as an element in the cause of death. With the occurrence of paralysis of peristalsis there is an absence of the normal gurgling sounds heard on auscultation of the abdomen. **Distention,** which in slowly infectious processes is sometimes the first symptom, may be moderate at first and limited to the coils of intestine in the immediate neighborhood of the original site of infection, thence extending gradually; in rapid and grave cases it soon becomes general and excessive, the skin of the abdominal wall becoming livid and shiny; the resonance everywhere is tympanitic. **Localized rigidity** of the abdominal wall is sometimes observed at first, this corresponding to the original site of infection; later on this rigidity becomes more marked and general. With increasing and excessive distention it may become lessened or disappear altogether. **Constitutional symptoms** due to septic absorption set in early in unfavorable cases. There is a rapid rise in the pulse-rate (from 120 to 160) in the severe cases; in those less severe the pulse-rate increases much less rapidly. A rate of even 120 is to be looked on as a serious symptom. The temperature is subject to great variations; more or less elevation is the rule, however. It may be excessively high or but slightly affected; occasionally and at the very last it is below the normal. The **intellect** may remain unaffected to the end. A drawn and anxious countenance is almost pathognomonic of the disease. A livid surface and blue finger-nails mark the onset of vasomotor paralysis. In mild cases, with but slow development of the disease, there may be but moderate disturbance of pulse and temperature. **Chills** are seldom complained of. **Serous exudation,** which finally becomes purulent if the patient survives, occurs.

In tuberculous peritonitis the only early symptoms in many cases are those which indicate general nutritive disturbances. There are digestive disturbances, progressive emaciation, and some swelling of the abdomen, which, later on, may become extreme. Pain may or may not be present.

Diagnosis.—It is of the utmost importance to distinguish between peritonitis and acute intestinal obstruction. Pain, distention, vomiting, and constipation may be present in both conditions. If the obstruction is in the small intestine, vomiting may be absent late in the case. One or two movements of the bowels may occur if the obstruction is above the ileocecal valve, and in rare cases fecal evacuations may be obtained during the entire course of peritonitis. In acute obstruction the pain is severe and paroxysmal; in peritonitis it is, as a rule, both severe and persistent. In obstruction the primary location of the pain is often the seat of the lesion, while in peritonitis it is most often referred to the epigastrium or about the umbilicus, and later becomes general. Acceleration of the pulse is present in both conditions. In the commencement of intestinal obstruction the temperature is not elevated; in peritonitis it may rise comparatively early. The onset of the attack in obstruction is generally sudden; in peritonitis, particularly in the less fulminating cases, this occurs more gradually.

Perforative peritonitis and **acute intestinal obstruction** may be combined in the same case, *e. g.*, strangulated intestine with gangrene and perforation. Irrespective of such a combination, all cases of obstruction tend to eventuate in peritonitis, and the differentiation is sometimes impossible without explorative abdominal section, particularly in cases in which the administration of opium masks the symptoms. Finally, the previous history of the patient, particularly with reference to the occurrence of former attacks of intra-abdominal inflammation to account for intestinal obstruction on the basis of bands, angulation, etc., is to be taken into account, as well as the possibilities of appendicitis, ambulant typhoid fever, suppurative diseases of the adnexa in females, and purulent collections or infectious conditions in the neighboring organs, and statements regarding the reception of injuries.

Tuberculous peritonitis is to be carefully differentiated from typhoid fever when it is unaccompanied by pain and before ascitic and pronounced abdominal swelling has occurred. Cases of tuberculous disease of the mesentery and its lymphatic glandular structures, and of the omentum, without ascites, simulate renal tumors, peritoneal cancer, appendicular abscesses, intestinal obstruction, inflammation of the adnexa, and even neoplasms in the abdominal wall. Ovarian, mesenteric, and hepatic cysts are to be excluded in the ascitic form of tuberculous peritonitis. The diagnosis often depends on the findings of an abdominal section. In typhoid perforation the accident rarely occurs before the eighteenth day of the disease. It is more frequently observed in males than in females and less frequently in children than in adults.

Prognosis.—Early shock and collapse are sometimes fatal in perforative peritonitis. Severe and persistent pain is the sign of rapid and extensive peritoneal infection. Dark brown, black, or coffee-colored vomited matter is the almost certain precursor of death. Simple regurgitation is a bad omen. A rapid rise of the pulse is significant. High temperature is always an unfavorable sign, though the reverse does not hold true. When paralysis of peristalsis is complete, there can be very little hope of recovery. Livid skin, cold extremities, and sweat are indicative of profound sepsis. If the pulse gradually and persistently increases in frequency and assumes either a gaseous or a thready character an unfavorable prognosis must be given.

In favorable cases the tenderness and rigidity remain localized for a time and then gradually subside. When bowel movements can be obtained, the infection, as a rule, is less virulent in character and hence the outlook is better. In favorable cases the vomiting ceases, the pulse-rate becomes slower, and the temperature lessens, until convalescence is established. When confined to the pelvic peritoneum, the disease pursues a more favorable course owing to the lesser opportunity for septic absorption due to the rapid sealing of the capillary lymphatics peculiar to this region.

Tuberculous peritonitis offers the same unfavorable prognosis as tuberculous disease elsewhere, when treated non-operatively. Of cases submitted to abdominal section, about four-fifths recover. In the nonascitic form the disease has reached a point where spontaneous cure may take place.

The Treatment of Peritonitis.—The modern treatment of peritonitis is based on our knowledge of the septic origin of the disease, and the recognition of the fact that its **chief danger consists in the absorption of the toxic products of the septic processes,** rather than in a spread of the inflammation itself. Measures to provide for the safe elimination of these products therefore form the most rational therapeutic indications.

Infection of the lymph-channels causes lymphangitis, and this in turn leads to the formation of lymph thrombi and consequent obliteration. In localities where the lymph-channels are large, absorption occurs before the lymph-channels can be obliterated, and the organism becomes overwhelmed. In the case of the smaller lymph-channels and the capillary network of absorbents such as exist in the pelvic peritoneum, the obliterating process takes place with comparative rapidity and the safety of the organism is correspondingly assured.

The indications for treatment, therefore, are, first, measures to remove the septic material from the peritoneal cavity; second, methods to favor the passage of whatever of this material there is still remaining, or which may subsequently occur, away from the dangerous diaphragmatic and intestinal areas and into the cavity of the pelvis, where the anatomic and physiologic conditions are such as to render its presence comparatively harmless.

In carrying out the first of these indications in mild cases of **infectious peritonitis** before vomiting becomes persistent, the method of intestinal drainage by the use of saline cathartics is to be employed. Later on in the disease they are useless. In **perforative peritonitis** they are positively contraindicated, since they increase the extravasation of liquid fecal matter into the peritoneal cavity. In this class of cases operative measures are alone applicable. These consist in opening the peritoneal cavity, and, after dealing with the original septic focus, cleansing the peritoneum as far as possible by flushing with large quantities of sterilized decinormal saline solution at a temperature of 110° F. and systematically and gently removing patches of fibrinoplastic material. During the first few minutes of the flushing process considerable quantities of the irrigating fluid are absorbed. This therefore furnishes a ready means of infusion. "Scouring" or rubbing the lymph patches should not be resorted to. These lymph patches harbor hordes of microorganisms and should be removed if possible by simply lifting them from the surface. Rough methods in their removal do positive harm. If **eventration** or **disemboweling** occurs, the intestines must be carefully protected against injury and chilling. They must not be permitted to drag upon their mesenteric attachments and should be kept well covered with gauze wet with saline solution at 110° F.

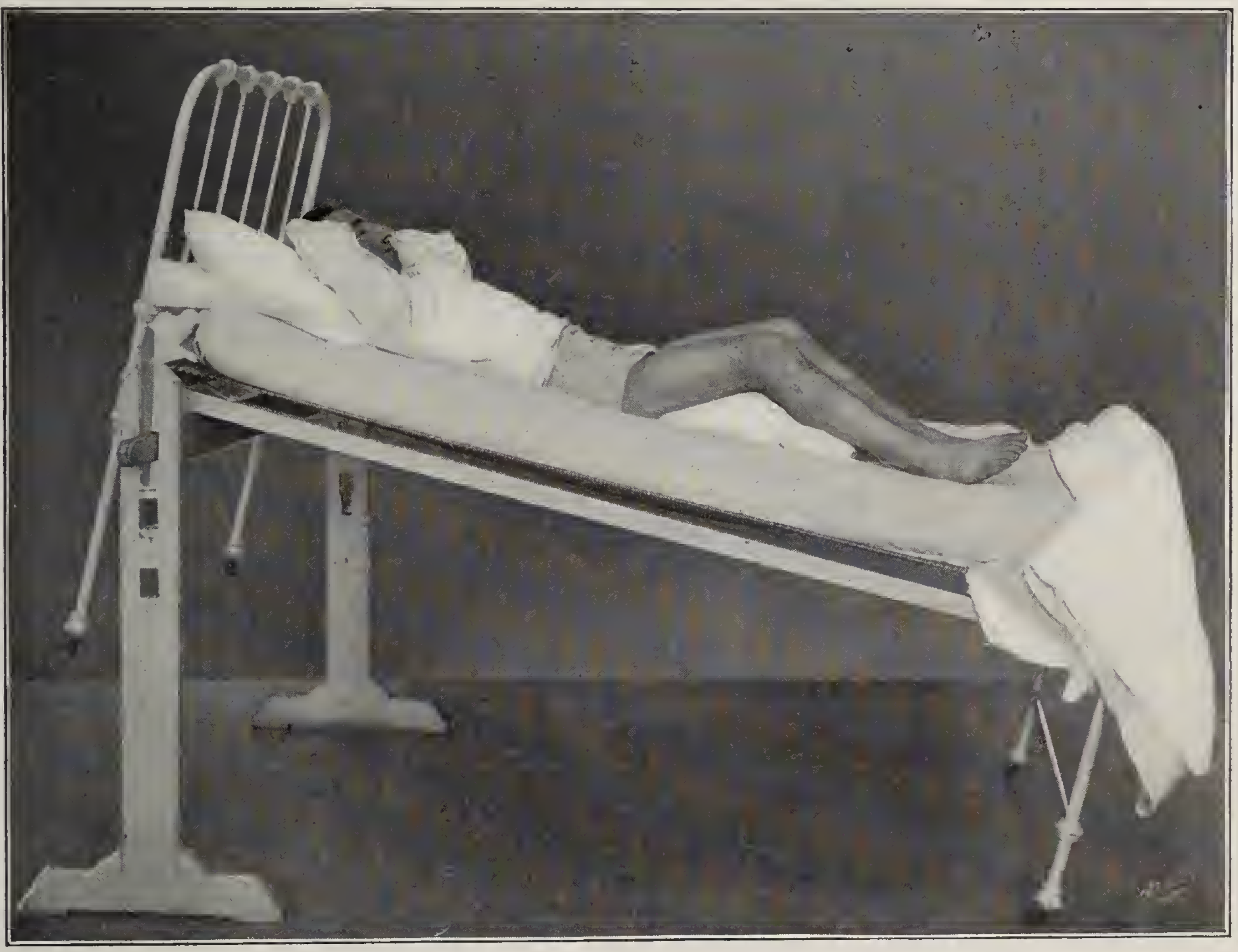

Fig. 415.—Elevated Head and Trunk Position.

The **second indication** is fulfilled by taking advantage of the force of gravity. According to J. G. Clark, there is normally a force in the peritoneal cavity which carries fluids and foreign particles toward the diaphragm, regardless of posture, though **gravity may greatly favor or retard the current.** To further the force of gravity and to counteract the force exerted by the diaphragm in attracting infectious material to its own neighborhood, the plan of placing the patient in the elevated head and trunk position, in order to facilitate the passage of fluids from the abdominal areas to the pelvis, is believed to be of value. The head of the bed is raised so that its plane is from 12 to 16 inches from the horizontal. The patient is prevented from slipping down in the bed by a large folded pillow placed beneath the flexed knees and resting against the thighs and buttocks. The pillow is prevented from slipping by a strong bandage passed through the folded portion and secured to the frame of the bed at its sides (Fig. 415). The elevated head and trunk position offers the additional advantages of assisting materially in relieving the nausea and vomiting, and of favoring peristalsis and the relief of distention by the passage of flatus. The results following the postural treatment have been in my experience extremely satisfactory.

Artificial drainage is provided for by large glass or rubber tubes carried to the deeper portion of the pelvic cavity, and strips of gauze or wicking led through these for the purpose of favoring the escape of the contents by capillarity. The tubes are aspirated every few hours with a pipet or a small syringe having a short piece of rubber tubing attached. The projecting end of the tube must not be included in the binder which secures the dressings of the abdominal wound, but must be dressed separately (Fig. 416).

In **typhoid perforation** early operation will occasionally save a life. With copious and rapid fecal extravasation in the absence of early and efficient operative interference, death takes place unexceptionally. Perforation from one coil of intestine to another, and even slight extravasations, probably occur frequently and pass unrecognized. In performing abdominal section for typhoid perforation the following points should be borne in mind: (1) the peritonitis may be due to other causes than typhoid perforation, such as acute intestinal obstruction, softened infarcts of the spleen, softened glands, abscesses of the bladder wall, suppurative cholecystitis, abscesses of ovarian or of hepatic origin, rupture of the spleen, and extension of inflammation from the adnexa and endometrium (Fitz); (2) there may be more than one perforation present; (3) no discoverable local lesion may be present to account for the peritonitis.

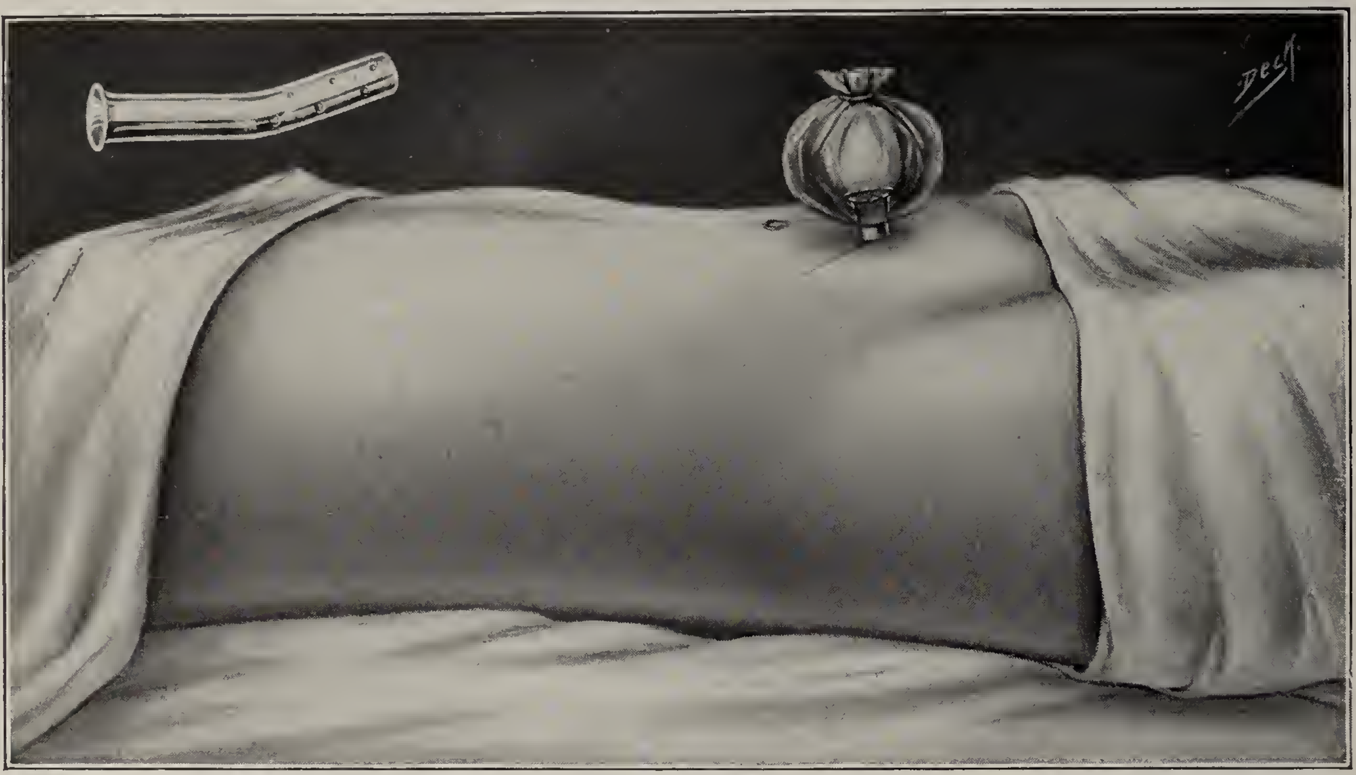

Fig. 416.—Separate Dressing for Drainage-tube.

Perforating Gastric Ulcer.—Ulcer of the stomach is most frequently situated at the greater curvature or close to the pylorus. It may occur on the anterior or the posterior wall; it is found least often at the cardiac orifice (Maylard). According to Brinton, the ulcers occurring on the anterior wall of the stomach perforate most frequently (85 per cent of all cases of perforating gastric ulcer). The position of the patient when the perforation takes place and the amount and character of the stomach contents are of importance; perforation with the patient in the upright position leads to rapid and extensive extravasation; if the accident occurs on an empty stomach, the consequences are much less grave.

The **symptoms** of perforating gastric ulcer into the free peritoneal cavity are those of perforative peritonitis. Unless the previous history assists, which it more frequently fails to do than not, the diagnosis is largely conjectural. Excessive rigidity of the abdomen from the very first of the attack is suggestive of gastric perforation. The accident, however, belongs to the class of hyperacute lesions in the abdominal cavity, the common features of which are profound shock, severe abdominal pain, and excessive tenderness.

The **treatment** is by early operation. The incision is made in the median line from the ensiform cartilage to the umbilicus, the stomach isolated, and the perforation sought. If the posterior wall is perforated, the anterior wall of the stomach is incised, the perforation sutured from within, and a gastroenterostomy performed to give the stomach perfect rest, since suture from within is not a very trustworthy procedure. When accessible from without, the Lembert suture is to be applied. The flushing of the abdominal cavity and the draining of the pelvis through special incisions in the right and left iliac regions, the use of glass tubes, and the closure of the abdominal wound complete the procedure.

Perforating Ulcer of the Duodenum.—Ulcer of the duodenum occurs more frequently in males than in females and most often between the ages of thirty and forty. Its most common location is within one or two inches of the pylorus and on the anterior wall; it may be found, however, on the posterior wall and at the inferior border. More than one ulcer may be present, and coincident ulcer of the stomach may occur. The **symptoms** of perforation into the free peritoneal cavity are those of perforative peritonitis in the upper part of the abdomen.

The **treatment** of perforating ulcer of the duodenum is suture through an incision made over the duodenum through the right rectus muscle. Trustworthy suture is difficult and the line of suture frequently separates.

THE SPLEEN

Spontaneous rupture of the spleen occurs in severe types of malaria and in the course of typhoid fever and other infectious diseases.

Inflammation of the spleen occurs with comparative ease from infection from the blood, owing to the slow blood-current in its large sized capillaries and veins, and the pervious character of the walls of the vessels. The changes which this organ undergoes in all infectious diseases are thus explained.

Abscesses of the spleen may occur after injuries, in the course of typhoid fever and other infectious diseases, and in connection with pyemia. **Chronic suppuration** is most frequently noticed in connection with actinomycosis and tuberculous infection. The suppuration may be diffuse or exist as separate foci. When the entire spleen is involved, the organ breaks down into a pulpy grayish mass. Abscesses of the spleen may rupture into the peritoneal cavity, into an adjoining viscus, through the diaphragm, or into the splenic vein. They may find their way through the abdominal or the thoracic wall. Rupture into the peritoneal cavity is usually fatal, death occurring from diffuse septic peritonitis. In rare cases the suppuration becomes encapsulated and a peritoneal abscess ensues, from which the pus may find its way into the retroperitoneal connective tissue and burrow in the direction of the rectum. The diagnosis of abscess of the spleen is obscure. There is pain in the neighborhood, with tenderness in the region of the lower ribs, and enlargement of the organ. Edema and swelling of the skin over the spleen may lead to the suspicion of perisplenic abscess. The presence of pus may be determined by exploratory puncture. The treatment consists in evacuation of the contents of the splenic abscess. The exploring needle should be followed by the knife, and, if adhesions have formed protecting the abdominal cavity, the abscess may be opened at once. In the absence of adhesions the wound may be packed and the final evacuation postponed for a few days. A rib may be resected if necessary. The possibility of actinomycosis as a cause of the abscess should be borne in mind. **Pyemic suppuration of the spleen** is not amenable to operative treatment. The same may be said of **tuberculosis** and **syphilis** of this organ. **Gummas of the spleen** are not common, the syphilitic enlargement being due to combined proliferation of the pulp and hypertrophy of the connective tissue of the organ. **Aneurism** of the splenic artery should be treated by removal of the spleen and extirpation of the aneurism.

Movable Spleen.—This may be congenital or acquired. The latter is the more common. The changes of position arise from gradual changes in the gastrosplenic omentum, which connects it to the stomach, and in the suspensory ligament by means of which it is attached to the diaphragm. Pregnancy, falls, and enlargement of the organ are usually assigned as causes. The spleen may descend to the brim of the pelvis. Pain due to circulatory disturbances in the organ and symptoms of indigestion from the dragging upon the stomach may occur. The pancreas and duodenum may likewise be dragged upon. Gangrene of the spleen from twisting of the pedicle may take place. If the wearing of a broad abdominal belt does not relieve the symptoms, Rydygier's operation of placing the spleen in an extraperitoneal pocket formed beneath the lower border of the thoracic wall may be performed. Extirpation for movable spleen may be resorted to if necessary.

Malformations of the spleen are very rare. Congenital absence of the organ has been observed in otherwise healthy individuals. The external form of the organ may vary; it is sometimes lobulated and has deep notches.

Tumors of the Spleen.—Primary neoplasms of the spleen are very rare. Of these, fibromas, angiomas, sarcomas, and echinococcus and dermoid cysts have been observed; 3.2 per cent of all cases of echinococcus cysts occur in the spleen (Trinkler). Tumors of the spleen usually render the organ very movable. The **treatment** is extirpation of the organ, particularly in the case of malignant tumors.

Chronic hypertrophies of the spleen include amyloid degeneration, and enlargements which occur in connection with leukemia and pseudoleukemia (Hodgkin's disease); in the latter, hypertrophy of the lymph-glands follows the enlargement of the spleen. Extirpation of the spleen in these conditions is not justified on account of the high mortality. Parenchymatous injections of solutions of carbolic acid and of Fowler's solution have been recommended.

Operations on the Spleen.—Incision of the spleen (**splenotomy**) is called for in abscesses and echinococcus cysts. The operation should be performed in two stages. The cyst or abscess wall is first exposed by abdominal section, the wound is packed with gauze, and the abscess cavity or cyst is opened a few days later. If adhesions already exist, the abscess or cyst may be opened at once. Either the thermocautery or the knife may be used. In the case of an **echinococcus cyst,** the cyst wall sometimes shrivels up after splenotomy, and the entire wall may loosen and be subsequently removed by simply grasping it with forceps and making traction. Injections of iodin water (one dram of the tincture of iodin to one ounce of water) will usually produce obliteration in obstinate cases. **Formal extirpation of the spleen** is the operation of choice in echinococcus cyst of this organ (Jonnescu).

Extirpation of the spleen (**splenectomy**) is indicated in tumors of this organ, in some cases of movable spleen (*vide supra*), and especially in injuries involving serious contusions with gangrene, severe intra-abdominal hemorrhage, and extrusion of the organ through an abdominal wound. Splenectomy is also indicated in enlargements of the spleen due to malaria, or **idiopathic hyperplasia** of the organ, especially if this occurs with consecutive cirrhosis of the liver.

The operation is performed as follows: The incision is made in the linea alba with a transverse incision to the left at its lower end, or over the left rectus muscle. The gastrosplenic omentum and the suspensory ligament are divided between two ligatures. Adhesions are treated in a similar manner. If the adhesions hold the organ firmly against the diaphragm, it will be impossible to remove it with safety. The thermocautery may be used in dealing with superficial adhesions and bleeding from tears in the parenchyma. The hilum is sought for and tied *en masse;* in addition, the artery and vein are each tied separately after division of the pedicle.

Removal of a spleen that has prolapsed through an abdominal wound, whether injured or uninjured, is a comparatively simple matter. In the case of a partial prolapse resection of the spleen may be made or complete extirpation practised. According to Ledderhose, partial resection or complete extirpation is safer than replacement of the organ. In **partial resection** the incision through the tissues of the organ is best effected with the thermocautery.

THE LIVER

The majority of cases of **abscess of the liver** outside of tropical countries are metastases of pyemia; they are difficult of recognition and almost invariably fatal. Dysentery is by far the most frequent cause of abscesses of the liver (524 out of 699 cases, Edwards and Waterman). They are very common in the tropics, where infectious inflammatory conditions of the bowels produce mesenteric thrombophlebitis; the decomposing clots, becoming dislodged, carry infection through branches of the portal vein and cause abscesses in the substance of the liver. Such abscesses will always prove fatal from septic peritonitis if the suppuration advances to the surface of the liver and ruptures into the abdominal cavity. With adhesions present the liver abscess may find its way externally through the abdominal wall. Adhesions between the liver and the intestinal canal sometimes lead to evacuation of the abscess into the bowel. Perforation of the diaphragm may take place and the pus finally find exit through a bronchus, in which case the patient may be literally drowned in the escaping pus. Suppurative inflammation also occurs after open contused wounds, stabs, or gunshot injuries. It may be due to intestinal ulcers and is also one of the complications following suppurative inflammation of the vermiform appendix (see Appendicitis). It may occur among infants from suppurative thrombophlebitis of the umbilic vein.

The principal **symptoms** of abscess of the liver are pain in the region of the liver, jaundice, digestive disturbances, and progressive emaciation. The pain often follows the course of the phrenic and the fourth cervical nerve and radiates to the shoulder. The fever is usually continuous; in chronic cases occurring in the tropics it may be intermittent and combined with chills. The liver is enlarged early and is tender on pressure. If the abscess points externally, there is swelling of the abdominal wall, which becomes edematous; as the pus approaches the surface fluctuation may be made out.

The **prognosis** is unfavorable. Most cases prove fatal either from the primary infectious disease, from pyemia or sepsis, or from rupture into the abdominal or the pleural cavity, with resulting septic peritonitis in the case of the former and septic pneumonia or suffocation in the case of the latter. The pus may find its way into the mediastinum or the pericardium. Multiple abscesses are quite uniformly fatal.

The **treatment** is operative. Simple incision or **hepatotomy** for abscess of the liver has been performed since the days of Hippocrates. In doubtful cases exploratory puncture after exposure of the organ and its isolation by gauze pads, repeatedly made if necessary, locates the site of the abscess cavity, and some of the pus is removed by aspiration. The needle is left *in situ* as a guide in making the incision. In cases in which the presence of an abscess is evident on exposure of the organ, the operation is performed in two stages if the abscess is not adherent to the abdominal wall. The liver surface is exposed at the site of the point of suppuration, the wound is packed with antiseptic gauze, and after three or four days the operation is completed by opening the abscess cavity with the thermocautery. Systematic cleansing by antiseptic irrigation and curettage of the abscess cavity should be effected. If the abscess ruptures into the pleural cavity, drainage should be secured by resection of a rib. This may likewise have to be resorted to in order to reach an abscess pointing toward the pleural cavity, the cavity of the abscess being reached by incision through the diaphragm. If rupture takes place into the pericardium, this should be exposed by costal resection and drained.

The Radical Cure of Ascites Arising from Cirrhosis of the Liver.—Ascites occurring in the course of cirrhosis of the liver is a direct result of obstruction to the portal circulation due to changes that take place in the hepatic structure. A certain amount of obstruction to the circulation in the liver is tolerated by the general intra-abdominal circulation and compensated for by the presence of anastomosing veins between the system of the portal vein and that of the inferior vena cava. Of these anastomosing channels, may be mentioned particularly the esophageal plexus with the azygos veins, the veins of the cecum and colon with the internal mammary veins, the hemorrhoidal with the hypogastric veins, the veins in Glisson's capsule with those in the hepatic round ligament, and the veins of the round ligaments with those of the epigastric. These anastomotic venous channels are sufficient to compensate for portal obstruction to the extent of preventing the occurrence of ascites in 65.6 per cent of the cases of cirrhosis (Lange). The development of ascites, both as to the period in which it appears in the case and as to its extent, will depend on the relation which the already existing collateral circulation bears to the demands made on it in the individual case.

The **Talma operation** is designed to strike the balance between the obstruction as it exists and the facilities afforded by the natural channels for compensating for the obstruction, by establishing adhesions between the intra-abdominal and the extra-abdominal structures, the vessels that develop in these adhesions serving as additional or accessory means of communication between the portal and the general venous circulation when compensatory dilatation of the already existing channels fails and ascites follows. Even with the additional channels afforded by the operation only about one-third of the cases operated on remain free from ascites. The total failures following the operation amount to about 60 per cent of all cases, these being about equally divided between the fatal cases and those unimproved (Greenough). Shock is responsible for death in the great majority of fatal cases. Autointoxication the result of the diversion of a certain amount of blood from the mesenteric veins directly into the general circulation adds somewhat to the risks of the procedure (Eck, Hahn, Tillmanns). The operation may not be required early in ascites, and, as has been already shown, it may not be required at all. Even if ascites is present, sufficient compensatory dilatation of already existing channels may take place after two or three tappings. This is the probable explanation of the occasional cures that follow repeated tappings. When the normal channels prove insufficient, however, the operation should be performed at once; delay, under these circumstances, is to invite disaster, owing to the patient's enfeebled condition. The indications can be fulfilled only by providing for adhesions that are sufficient in extent and whose vessels, dilating as the demand is made on them, may serve to maintain the balance between the obstruction, on the one hand, and the intra-abdominal vascular tone on the other.

The steps of the operation are as follows: In order to relieve the respiratory embarrassment the abdomen is tapped the night before, and as much fluid as possible drawn off. The incision reaches from the ensiform cartilage to half-way between the umbilicus and the pubes. The edges of the incision are widely retracted, all fluid thoroughly removed by mopping with sterile gauze, and the contents of the cavity thoroughly wiped by coarse crash laparotomy pads. The upper surface of the liver is scraped with a scalpel, as well as the adjacent parietal peritoneum and that covering the diaphragm. Finally the freshening process is completed by **"scouring"** the peritoneal surfaces with a small piece of crash held in a sponge forceps. The peritoneal surface of the spleen is included in the latter process. The round ligament of the liver is shortened by suturing it in folds and attaching it to the parietal peritoneum and the rectus muscle. In order to effect still further approximation between the parietal surface of the peritoneum and the peritoneal covering of the liver, the latter organ is sutured by its anterior edge to the parietal peritoneum. Finally the omentum is sutured to the parietal peritoneum in a transverse direction.

A reaccumulation of the fluid may take place. This is to be relieved by tapping, which should be repeated if necessary until the new venous channels that form in the adhesions are competent to compensate for the portal obstruction, as evinced by a cessation of the accumulation. Time is required for the establishment of the artificial collateral circulation, and pending this palliative treatment of the ascites is indicated.

Carcinoma of the Liver.—The existence of primary cancer of the liver was at one time denied, yet there can now be no doubt of its occurrence, though the frequency with which carcinoma of this organ occurs secondary to the disease elsewhere somewhat overshadows the fact of its occurrence as a primary affection. It occurs with equal frequency in both sexes, and the age of selection is in accordance with the average age of cancer patients, namely, between forty and sixty. It occurs in the form of dense white nodules, or as tracts of soft infiltration of an olive green or yellow color, these appearances presenting both on the surface and in the interior of the organ. In primary carcinoma the nodules are almost always single, while in secondary deposits they are multiple.

It was this circumstance of the single character of primary carcinoma of the liver and the desire to confirm the diagnosis in a young woman of twenty-eight, who showed no trace of the disease elsewhere, and who had a syphilitic history as well, that led the author as early as 1893, at the Brooklyn Hospital, to resect the cancerous nodule. The patient perished in the course of a year from local recurrence.

The structure of hepatic cancer corresponds to both the tubular and the acinous type. The carcinomatous structure, however, does not conform so closely to that from which it arises as cancer elsewhere, nor even so closely as does that of the new growth in adenoma of the liver.

Enlargement of the glands takes place, jaundice, more or less permanent, occurs, and ascites is almost always an accompanying symptom.

The lymph-glands in the portal fissure and the mediastinum become infected. Dissemination is uncommon, though secondary nodules have been found in the lungs.

Secondary deposits in the liver usually assume larger proportions than in the lungs; both in the liver and in the lungs they afford favorable conditions in which cancer emboli, carried in the one case by the portal circulation and in the other by the pulmonary, may grow.

THE GALL-BLADDER AND BILE-DUCTS

Absence of the gall-bladder, hour-glass contraction of the viscus, abnormal narrowness or width of the bile-ducts, and abnormalities in the opening of the common duct into the duodenum have been observed. No special surgical interest attaches to these congenital malformations, except that in operating for gall-stones on cases of **hour-glass contraction,** it may be necessary to perform dilatation of the constricted portion.

Inflammation of the Gall=bladder and Bile=ducts.—These may be the subject of catarrhal inflammation. **Acute catarrhal cholangitis** gives rise to what is known as **catarrhal jaundice,** through swelling of the mucous lining of the common bile-ducts, which has but a limited caliber at best. It is an extension of inflammation from the duodenum, the obliquely implanted and narrow terminal portion of the duct at the duodenum becoming obstructed first. It may also be secondary to inflammation of the parenchyma of the liver, carcinoma of the liver, gall-stones, and echinococcus. It occurs also in the course of acute infectious fevers, pneumonia, syphilis, and the uric acid diathesis.

Chronic cholangitis may be a sequel of the acute form, but it is more commonly a concomitant of organic disease of the liver, such as cancer, echinococcus, abscess, etc., and in such cases it is frequently the cause of the jaundice. In some cases in which jaundice is present, with gall-stones in the gall-bladder or the cystic duct, the obstruction to the flow of bile arises from inflammatory swelling due to extension from the seat of the impacted gall-stone (Riedel).

Desquamating angiocholitis (Mayo Robson) is an inflammation of the ramifications of the bile-ducts, the lining of which is desquamated. Thudichum considers that the casts thus thrown off often form the nucleus of gall-stones.

Catarrhal Cholecystitis.—Chronic catarrhal inflammation of the gall-bladder without jaundice is a distinct disease not necessarily associated with the presence of gall-stones. The treatment for this class of cases is operative; cholecystotomy is performed and drainage continued for two weeks or more. If in a case of long duration, the gall-bladder is found to be greatly thickened, removal of the gall-bladder (**cholecystectomy**) is the preferable operation. The gall-bladder may be found contracted and surrounded by adhesions. The surgical treatment in these cases should always be followed by a medical course, for the purpose of relieving the associated chronic catarrh of the bile-ducts.

Inflammation of the gall-bladder and bile-ducts may be **croupous** or **membranous,** and occurs in connection with attacks of membranous enteritis. The formation of membrane in the biliary passages obstructs the flow of bile, and, in the case of the gall-bladder, gives rise to spasms of the latter similar to those caused by gall-stones or masses of thick mucus (Powell). The presence of membranous intestinal casts in the feces from the associated membranous enteritis may aid in the diagnosis. The **treatment** consists in the regular administration of Carlsbad salts in the morning. If the symptoms persist, cholecystotomy should be performed, or even cholecystectomy, as in catarrhal cholecystitis (*vide supra*).

Suppurative Inflammation of the Biliary Passages.—Inflammation of the gall-bladder of a phlegmonous character (**phlegmonous cholecystitis**) is due to infection of the walls of the gall-bladder from microorganisms which find their way into the viscus through the bile-ducts. The bile, which at one time was supposed to have an antiseptic action, is now known to be not even always sterile (Bloch). The **Bacterium coli commune** is most frequently found, though staphylococci and streptococci may be present (Netter, Lockwood). Chiari found the typhoid bacillus present in the gall-bladder in 19 out of 22 cases of typhoid fever; in 15 cases it was present in pure culture. In 13 of the cases there were evidences of inflammatory changes in the viscus.

The **symptoms** of phlegmonous cholecystitis in the majority of cases are those of an acute attack of local peritonitis in the neighborhood of the gall-bladder. This peritonitis spreads with more or less rapidity, until it becomes general. The onset is usually sudden, with pain in the right side of the abdomen, fever, intense depression, tenderness over the gall-bladder, and rigidity of the upper portion of the right rectus muscle. Tympanites develops rapidly, vomiting is persistent, and the peritoneal facies develops (see Peritonitis, page 34). The attack may be subacute in character and associated with gall-stones; an intermediate stage between simple empyema and acute phlegmonous cholecystitis (Mayo Robson) may be present. **Gangrene of the gall-bladder** may supervene (**gangrenous cholecystitis,** Hotchkiss, Richardson, Delatour). The gangrene is due to thrombosis of the nutrient vessels, bacterial infection, and intravesical tension. The **diagnosis** of phlegmonous cholecystitis is made on the basis of the acute character of the attack and the localization of the pain and tenderness at the gall-bladder. While it may be mistaken for a perforative lesion in the vicinity, the disease for which it is most likely to be mistaken is acute appendicitis. The symptoms of peritoneal involvement are common to both. In any event exploratory abdominal section is appropriate in all the conditions for which this affection may be mistaken. In cases not submitted to early operation the **prognosis** is most unfavorable. The **treatment** is prompt opening of the abdomen. The further steps of the operation will vary according to the conditions found. The gall-bladder should be incised and drained, and removed if gangrene is present. In the subacute cases with localized symptoms, cholecystotomy, removal of gall-stones, and drainage are indicated.

Suppurative catarrhal inflammation, **suppurative cholecystitis,** or **simple empyema** of the gall-bladder, is usually associated with obstruction of the cystic duct by gall-stones. Infection by pyogenic organisms of a simple catarrhal cholecystitis gives rise to it. Its presence may give rise to the phlegmonous variety, this depending on the accident of an additional and virulent infection of the structure of the wall exclusive of its mucous membrane. The symptoms will depend at first on the cause, which, in the vast majority of cases, will be found to be gall-stones, the preceding history of which may be obtained. There may be swelling beneath the right lobe of the liver, continuous pain, localized tenderness, and the presence of a tumor. The latter, before adhesions form, will move with respiration. Ulceration and perforation, if adhesive barriers have formed, are followed by external pointing of the abscess; otherwise diffuse septic peritonitis will supervene. If the abscess ruptures externally gall-stones may be discharged or may lodge in the fistulous openings. The pus may burrow posteriorly and simulate a **perinephritic abscess.** The constitutional symptoms are slight at first. With the occurrence of ulceration of the mucous membrane there is increase of fever, and chills or rigors. The **treatment** of empyema of the gall-bladder demands abdominal section, aspiration to get rid of the purulent contents, incision, removal of gall-stones, and drainage. If the gall-bladder appears greatly damaged, it should be excised.

Infective Cholangitis.—This is a catarrhal inflammation of the bile-ducts. It is usually due to gall-stones in the common duct, which lower the vital resistance of the tissues either by pressure or by abrasion, or by both, and permit bacterial infection through the duodenal orifice. The **previous history** includes spasmodic pain in the right hypochondrium, without jaundice; the latter may occur after an unusually severe attack. The gall-stone may pass after such an attack, or the latter may be repeated (**impacted gall-stone in the common duct**). These attacks may be accompanied by chills, followed by a rise of temperature to 104° or 105° F. The jaundice may persist between the attacks. Tenderness over the gall-bladder or in the epigastric region may be elicited, but a tumor cannot usually be made out unless there is coincident cholecystitis, since a gall-bladder containing gall-stones and not having this complication is usually contracted. The disease may last for years and the patient finally recover; it may develop into the suppurative form (*vide infra*), or it may assume an acute form and prove fatal from septic complications in the vicinity (diffuse hepatitis, abscess of the liver, cholecystitis, etc.), or from septic endocarditis, pneumonia, pleuritis, etc. The **treatment** is largely preventive. Every case of gall-stones which does not improve under medical treatment should be operated on by incision of the gall-bladder, removal of the gall-stones, and drainage of the viscus. With the development of cholangitis this should still be done, with, in cases of impacted stone, the addition of incision of the duct (**choledochotomy**).

Suppurative Cholangitis.—In the vast majority of cases this is due to cholelithiasis. It may also arise from hydatid disease, and very commonly from carcinoma of the bile-duct; it may likewise complicate acute infectious diseases (typhoid fever, epidemic influenza, etc.). It may be due to invasion of the bile-ducts from the duodenum by the common round worm, or ascaris (Mertens). The immediate and remote **complications** are the same as in acute infective cholangitis. The **symptoms** are progressive enlargement and tenderness of the liver, and of the gall-bladder as well if the cause is in the common duct and the gall-bladder has not been previously contracted. In the latter event, or if the obstruction is in the hepatic duct, the signs of an empyema of the gall-bladder will be absent. Jaundice is always present; fever with chills is a constant feature of the disease, with rapid loss of flesh and strength. Pneumonia and suppurative pleuritis are dangerous complications. The entire course of the disease is fraught with danger, unless prompt operative interference saves the patient. The **treatment** is incision of the gall-bladder and prolonged drainage (**cholecystostomy**), to which it may be necessary to add incision of the duct (**choledochotomy**). For the purpose of exploring the duodenal orifice of the common duct in cases of stenosis at this point, incision of the duodenum may be necessary (Abbe, 1891; Terrier, 1894). The biliary fistula should not be permitted to close until the discharged bile is practically sterile.

Tuberculous cholangitis is a rare condition, and depends on an extension of tuberculous infection from the intestine.

Ulceration of the Gall-bladder and Bile-ducts.—These lesions are of importance principally from the adhesions that they produce, the hemorrhage to which they may give rise, the strictures that sometimes follow and the fatal peritonitis that may follow perforation into the peritoneal cavity. **Adhesions** about the gall-bladder are of surgical importance as showing the frequency of local peritonitis in connection with cholelithiasis and possible ulceration. They may produce dilatation of the stomach from kinking of the pylorus (Mayo Robson's case), or prove a serious complication in an intended cholecystectomy. Severe **hemorrhage** may occasionally follow ulceration, as shown by a fatal case attributed by Mayo Robson to Dr. McGregor. **Stricture** either of the gall-bladder or of the bile-ducts is one of the rare sequels of ulceration.

Perforation of the Gall-bladder and Bile-ducts.—This must always be regarded as a serious accident. The danger is proportionate to the site of the ulceration, to the efficiency of the adhesive barriers, and to the virulence of the infective agent. The perforation may lead into an adjoining hollow viscus (stomach, intestine); into the liver substance, giving rise to abscess; into the pancreas, resulting in acute pancreatitis; rarely into the pelvis of the kidney. The perforation may lead into the abdominal wall, giving rise to a superficial abscess that discharges gall-stones. Finally, and most important, if the perforation leads into the unprotected cavity of the peritoneum, fatal diffuse septic peritonitis is almost certain to ensue (see Peritonitis). The only **treatment** is **immediate abdominal section.** Opium should not be given except during the preparation for the operation, and then only in quantities sufficient to bridge the patient over. After the abdominal cavity is cleansed the rupture may be searched for and sutured if the patient's condition admits of it. Usually, however, a strip of gauze leading from the gall-bladder region, a drainage-tube into the bottom of the pelvis, and after-treatment in the elevated head and trunk position must suffice (see Treatment of Peritonitis, page 38).

Biliary fistulas are quite common after nature's efforts to get rid of gall-stones; rarely they are due to cancer. Those opening on the skin are of surgical importance; those opening into adjoining viscera usually heal spontaneously, though they may be of a size to give exit to gall-stones sufficiently large to produce subsequent intestinal obstruction. The cutaneous variety may be direct or indirect. The latter open into some other organ and finally appear externally. **Post-operative biliary fistulas** may sometimes be healed by application of the thermocautery to the edges, if they do not close spontaneously. If the ducts are not obstructed, and the fistula is small, the abdomen may be opened, the gall-bladder detached, and the opening closed by inverting its edges and suturing. If the obstruction is at the cystic duct, the gall-bladder may be removed; but if in the common duct and otherwise inoperable, a communication must be made, if possible, between the gall-bladder and the duodenum (**cholecystenterostomy**). A contracted gall-bladder may deprive the patient of the benefit of this procedure. In order to prevent post-operative biliary fistulas after cholecystostomy, the serous surfaces adjoining the edges of the opening in the gall-bladder may be inverted in such a manner that rapid closure of the opening may be obtained after removal of the drainage-tube (Jones). R. S. Fowler has developed the technic of this device by encircling the incision in the gall-bladder with a pursestring or tobacco-bag suture, including the serosa and muscularis, securing a drainage-tube in position by two chromicized catgut sutures in the raw edges of the incision, and then producing invagination of the serous surfaces by pressure on the drainage-tube, at the same time tightening the encircling suture. Return of the invaginated portion is prevented by a turn or two of the catgut suture through the wall of the tube (Fig. 417). Robson sutures the edge of the gall-bladder to the aponeurosis instead of to the skin.

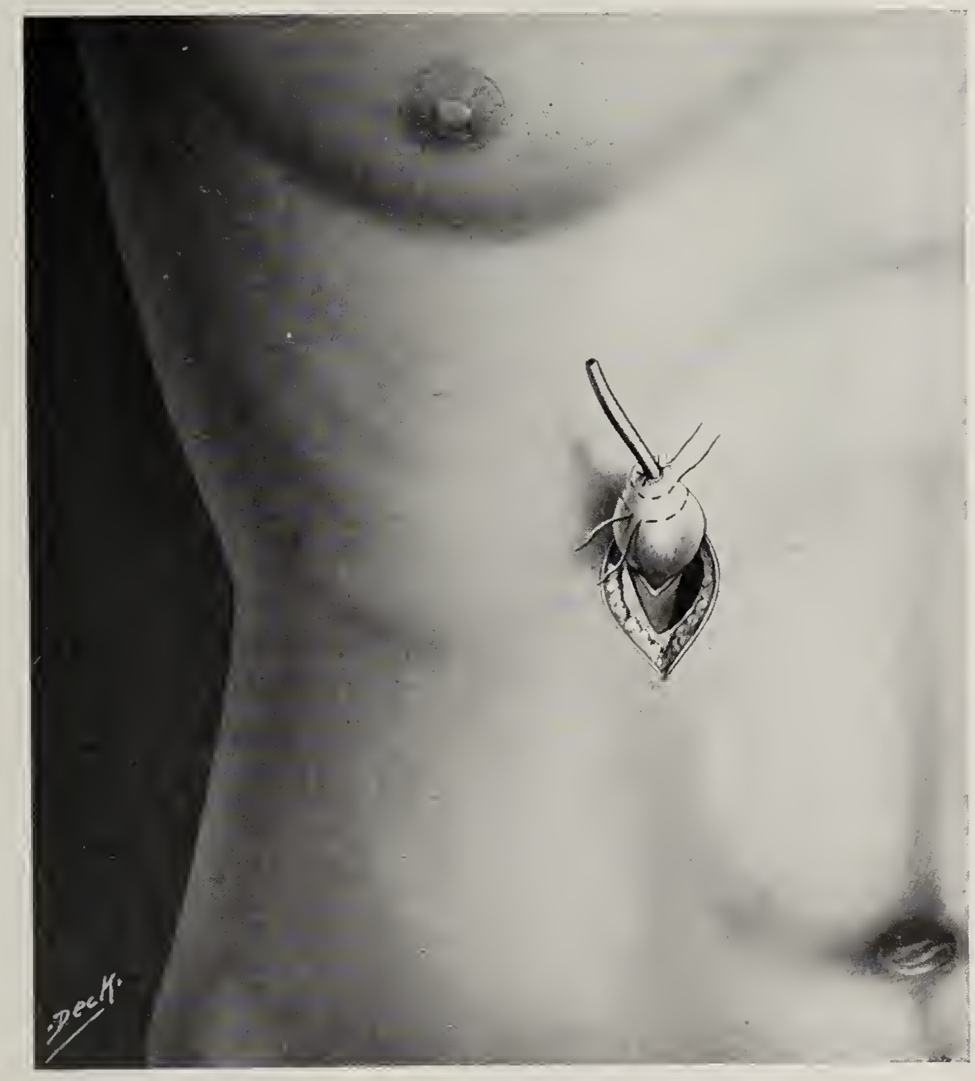

FIG. 417.—CHOLECYSTOSTOMY.

Showing the site of the incision in the right rectus muscle just below the costal margin and on Robson's line (a line drawn from the nipple to the umbilicus). Also the method of inversion of the gall-bladder around a rubber drainage-tube.

For intestinal obstruction from gall-stones see Intestinal Obstruction.

Tumors of the Gall-bladder and Bile-ducts.—These are by no means common, if the term is limited to neoplasms. The latter may be classified as simple and malignant new growths. Of these, **carcinoma of the gall-bladder** is the most important. As a primary affection it is somewhat rare. Usually it is secondary to cancer of other organs in the vicinity. When primary, it is associated with gall-stones and may be due to the irritation of the latter. When occurring as a secondary affection, the calculi may be a sequence of the diseased condition. Extension from the liver takes place by continuity and the colon and pylorus soon become affected.

The disease occurs in women with the same relative frequency as does cholelithiasis, namely, three times as often as in men; in both affections the age of the patient is identical, namely, between fifty and sixty. The disease arises commonly in the fundus; less frequently it is observed in the ducts. The walls of the viscus are infiltrated and greatly thickened, only a small cavity remaining, which is usually occupied by calculi; in a few instances villous processes of the disease have been found. Seeding dissemination in the peritoneal cavity may occur from the bursting of a budlike projection on the serous covering of the gall-bladder. Secondary deposits occur in the liver and the lymphatic glands in the portal fissure are involved.

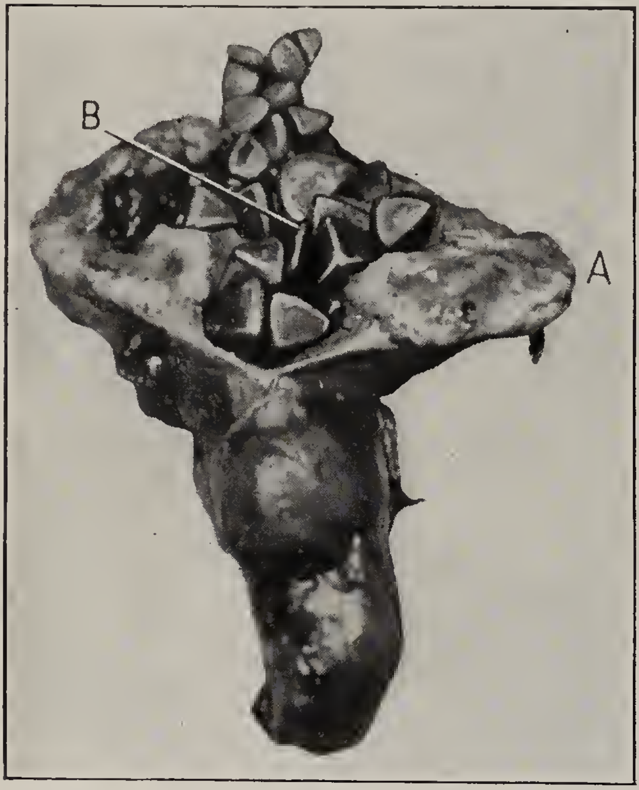

Fig. 418.—Cancer of Gall-bladder. A, cancerous growth; B, gall-stones.

Jaundice is present in about one-third of the cases. The disease usually proves fatal in about six months.

In the rare instances in which the disease is found to be limited to the gall-bladder, in cases suitable for exploratory abdominal section, attempts may be made at removal. Even secondary growths in the liver have been successfully removed with the gall-bladder (Robson).

Sarcoma of the gall-bladder is occasionally found. **Simple growths** of the gall-bladder and in the common duct are rare. The reported cases have been instances of fibromas, villous growths, papillomas, and adenomas. These probably form the basis of carcinomas.

Tumors formed by the gall-bladder itself are due principally to distention with bile, concretions, pus (empyema), mucus (dropsy of the gall-bladder), and hydatid cysts. Cases of calcified gall-bladder and adipose thickening of the walls occur. These enlargements may vary in size from the almost imperceptible gall-bladder filled with gall-stones to those of considerable proportions due to hydatids. The **enlargement takes place downward and forward,** as a rule. The position of the tumor varies with the size of the liver. In uncomplicated cases the **pear-shaped outline** may be made out, the mass having some mobility; the sulcus between it and the liver may be perceptible. Pressure from the right loin (**bimanual palpation**) may render it more distinct. Placing the patient in the knee-chest position may bring it out more clearly (Robson). Fluctuation can rarely be obtained. Distention of the surrounding intestines renders percussion unreliable. The tumor may be seen to **move with the respirations,** in cases in which there are few or no adhesions. Tenderness is a variable symptom, depending on local peritonitis when present. Blocking of the common bile-duct may cause **jaundice.** This symptom, associated with a tumor in this region, should always give rise to a suspicion of malignant disease of the liver or gall-bladder and its ducts, with cancer of the head of the pancreas as an alternate probability. The **differential diagnosis** of enlargements of the gall-bladder must eliminate the following: (1) movable right kidney; (2) tumor of intestine and fecal impaction; (3) tumor of the pylorus; (4) tumor of the liver; (5) abnormal projection, or accessory lobe of the liver. This may be difficult under the most favorable circumstances. The previous history, the general outline of the tumor, its mobility and movements with respiration, the presence of a sulcus between the tumor and the liver, the jaundice if present, and, finally, the associated symptoms, must all be taken into account. If exploratory puncture is resorted to and fluid found, sufficient of this must be withdrawn to relieve intravesical tension and prevent leakage after the withdrawal of the needle. Finally, exploratory abdominal section through a small incision involves but little risk.

Tumors of the bile-ducts may be either cystic or solid. The former are usually dilated portions of one or another of the ducts. Solid growths may be simple or malignant, the latter predominating. Jaundice is frequently the one suggestive symptom, provided there is nothing else to account for it. The diagnosis is to be made only operatively. In a greatly dilated common duct anastomosis with the small intestine (**choledocho-enterostomy**) has been successful (Sprengel, 1891). Marcel Baudouin has grouped the recorded cases of extirpation of simple biliary cysts under the heading of **cholangiectomy.**

Gall=stones or Cholelithiasis.—The records of autopsies show that gall-stones are present in from 5 per cent to 20 per cent of all cadavers. They are usually multiple and marked by facets. They vary in size from sandlike particles to a walnut or even a hen's egg, and their number may be very large, several hundred having been frequently removed at an operation. They usually consist of cholesterin, bile pigment, calcium carbonate, and magnesium salts. They are found most frequently in the gall-bladder, though they may have their origin in the ducts. **Stagnation of bile** may predispose to gall-stones, the actual formation depending on the retention in the biliary passages of such detritus as cast-off cells, and the presence of cholesterin crystals and mucus. **Bacterial influences** may play an important part in their production, and typhoid fever has been supposed to stand in a causative relation, these producing inflammatory disturbances in the biliary passages and thus favoring the formation of concretions. They occur more frequently in females than in males. This is explained by tight lacing and the resulting compression of the bile-ducts (Marchand).

Their **clinical course,** in the case of large stones, is characterized by attacks of severe pain when they pass through the cystic or common duct or become impacted. The pains commence in the right hypochondrium or in the epigastrium, radiating over the abdomen and to the right subscapular region. Nausea and vomiting may be present. Jaundice may or may not follow the attacks of paroxysmal pain. Bile, however, is usually present in the urine. Dilatation of the gall-bladder from impaction of a stone in the common duct is rare (Courvoisier). The symptoms may disappear as the gall-stone passes into the intestine or into the gall-bladder. In the latter case more or less discomfort, together with tenderness at the site of the gall-bladder, may persist after the attack. Permanent and complete obstruction to the discharge of the bile may lead to death from an excessive accumulation of bile in the blood (**cholemia**). The radicles of the hepatic ducts become dilated and degenerative changes in the liver ensue. The feces become **light gray** or **clay-colored.** Movable kidney may be associated. Bacterial infection occurring, inflammatory affections of the liver and gall-bladder arise (*vide supra.*)

When gall-stones are formed in the hepatic ducts and their radicles their migration to the common duct and thence into the duodenum takes place. When formed, as they most frequently are, in the gall-bladder they pass into the cystic duct and on to the intestine. The gall-stone may become lodged in the narrowest part at the diverticulum of Vater, whence it may be gradually forced by the pressure of bile behind it into the duodenum and finally discharged with the feces. **Superficial ulceration** at the point of impaction sometimes produces subsequent stricture. **Deep ulceration** is followed by perforation into adjoining hollow viscera or through the abdominal wall. Unusually large stones may produce death from intestinal obstruction or perforation (see Ulceration of the Gall-bladder and Bile-ducts).

The **treatment** of cholelithiasis consists in the administration of alkaline saline waters (particularly hot Carlsbad), which act by stimulating the peristalsis of the digestive tract, in which the biliary passages take part. This and the increased flow of blood to the parts are beneficial. Injections of large quantities of hot water *per rectum* are recommended for the same purpose. So-called solvent remedies are worthless. The system of diet and exercise adopted at certain watering-places, together with the administration of large quantities of diluents, principally water, sometimes gives beneficial results. The concretions passed after the administration of olive oil, a much vaunted remedy, are not biliary calculi, but consist of oleic, palmitic, and margaric acids combined with lime. Oleate of soda may be tried.

The **indications for operative interference** are the following: (1) the failure of medical treatment to relieve the symptoms attributable to the presence of gall-stones; (2) the presence of sequels of cholelithiasis, namely, phlegmonous cholecystitis and gangrene, ulceration of the gall-bladder and perforation into the abdominal cavity, and infective cholangitis.

Among exploratory operative measures puncture and "sounding" for gall-stones should be discouraged and replaced by a small exploratory incision under local or spinal cocainization, if necessary.

In all operations on the gall-bladder or its ducts a sand-bag should be placed under the back (Robson, see Fig. 419) and a vertical incision separating the fibers of the right rectus muscle employed. In order to gain more room the inner half of the muscle may be divided by an incision at the costal margin extending to the ensiform cartilage.

The particular operative measure to be applied in the individual case cannot be decided on until the abdomen is opened. The conservative operation consists of incision (**cholecystotomy**); the radical procedure is extirpation (**cholecystectomy**).

Thorough exposure and digital exploration should be made as soon as the abdomen is opened, before proceeding further.

Incision of the gall-bladder, after it has been exposed by a longitudinal incision through the right rectus muscle, is preceded by aspiration to relieve the tension and prevent unnecessary soiling of the peritoneum. If the gall-bladder can be brought easily into the abdominal wound, it may be sutured to the aponeurotic structures at the upper angle of the wound (not the skin), and then incised and a drainage-tube introduced. The preferable method, however, is that by invagination, in which case the rubber tube is to be surrounded by a narrow strip of antiseptic gauze and led out of the abdominal wound (see page 51). Adhesions quickly form about the gauze and the site of the tube is walled off by these. In order to prevent unnecessary soiling of the dressings with bile, the tube may be led to a receptacle, either incorporated in the dressings or placed alongside the bed.

Thorough exploration and clearing out of the gall-bladder and ducts as far as possible are necessary. The scoop should be employed, and the neck at the site of the cystic duct, as well as the course of the common duct, examined both from the interior and the peritoneal side. Practically the same steps are taken in empyema. The operation in two stages consists in exposing the gall-bladder, suturing it if practicable to the aponeurosis, and, if not, packing down to the point of intended opening with antiseptic gauze, and incising.

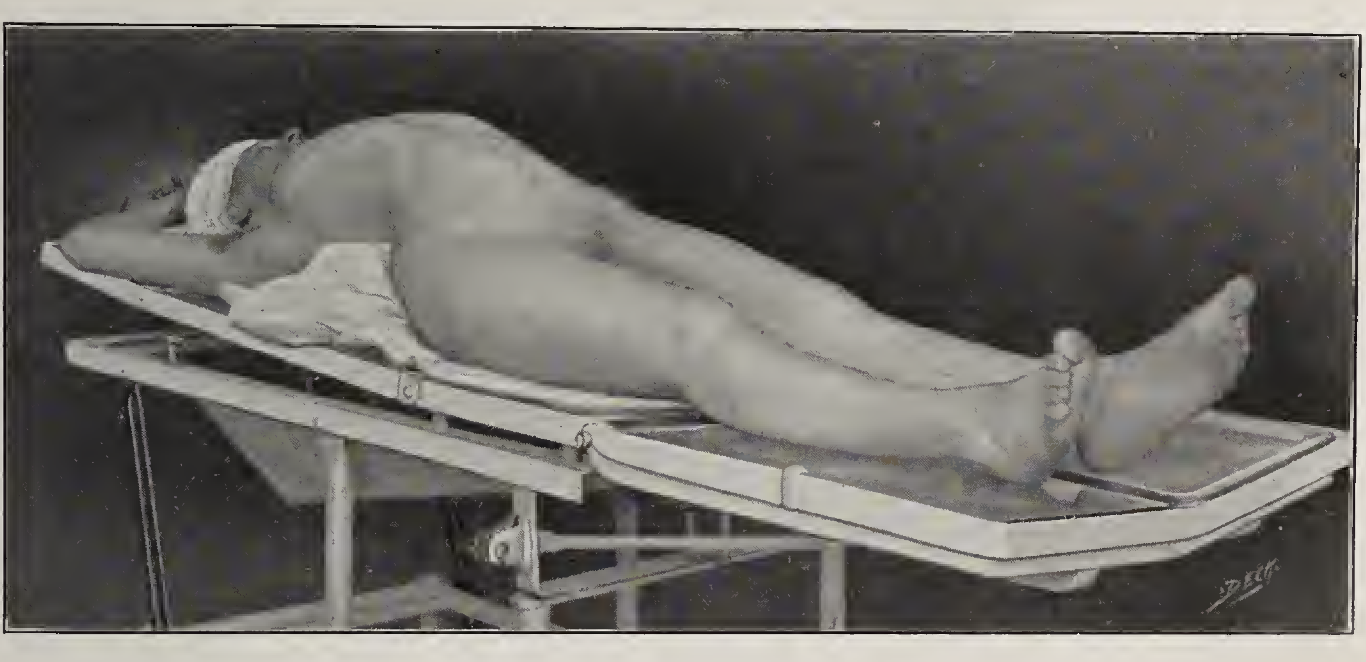

FIG. 419.—ROBSON'S POSITION FOR OPERATIONS ON THE GALL-BLADDER, ETC. Note cushion under back.

Extirpation of the gall-bladder is indicated as follows: (1) in phlegmonous cholecystitis and its sequel, gangrene; (2) in cases in which the gall-bladder is greatly contracted; (3) in damaged conditions of the wall of the gall-bladder, *e. g.*, in multiple superficial ulcer, or in perforating ulcer; (4) in stricture of the cystic duct; (5) in pronounced disease of the gall-bladder walls, whether inflammatory or arising from new growths. The gall-bladder should not be removed if the common duct is obstructed. The technic includes blunt detachment of the gall-bladder from the liver, which should be commenced at the site of the cystic duct, the peritoneum at the junction of the two being incised to facilitate this; ligation with catgut and division of the cystic duct; cauterization of the stump by the thermocautery, or by applications of pure nitric or carbolic acid; finally, the leading of a "safety" strip of gauze from the site of the stump and out of a separate opening made laterally close to the ribs. This method of drainage is designed to prevent the occurrence of ventral hernia.

In whatever direction the drainage strips are led they should be kept, as far as possible, from coming in contact with the stomach and duodenum, in order to prevent the formation of adhesions in these regions and the future occurrence of troublesome symptoms from this cause. The original operation wound is closed.

The **causes of failure of relief of symptoms** following operations for gall-stones are as follows: (1) delay in seeking surgical relief; (2) incomplete removal of stones; (3) secondary obstruction of the cystic duct; (4) insufficient drainage, particularly in cases of accompanying chronic pancreatitis; (5) overlooked stones in the common duct; (6) post-operative adhesions (W. J. Mayo).

THE PANCREAS

Inflammations of the pancreas are rare. In all probability they are most frequently due to extension of infectious inflammation along Wirsung's duct from the ampulla of Vater at the duodenum. In cases in which no accessory pancreatic duct enters the duodenum independently a gall-stone lodged low down in the common duct will cause obstruction to the flow of pancreatic secretion and lesions of the pancreas will result (Opie, Lund). Pancreatic lesions may occur in the course of infectious diseases, *e. g.*, typhoid fever, as either an interstitial inflammation or a parenchymatous degeneration. **Acute pancreatitis** is sometimes associated with hemorrhages (**hemorrhagic pancreatitis**), and gangrene or necrosis of the pancreas sometimes follows acute inflammation. Repeated attacks of collapse, with intervals of apparent improvement, characterized the clinical course in three cases of acute hemorrhagic pancreatitis observed by the author. This has also been noted by Fitz. Death may occur suddenly in consequence of hemorrhage of the pancreas (**pancreatic apoplexy**). The loss of blood is strikingly small in these cases. In cases of hemorrhagic and gangrenous pancreatitis the fat in the neighborhood of the pancreas undergoes fat necrosis (Balser). This may occur with or without hemorrhage and lead to sudden death. Hemorrhage may take place from rupture of a vessel in the wall of a cyst and the latter in its turn may rupture. The large amount of thin brownish fluid found on abdominal section in cases of acute pancreatitis (four cases in my experience) is probably due to this. **Suppurative pancreatitis** may result primarily from direct infection from within the intestinal canal, from indirect infection following the access of pyogenic microorganisms from the blood, or secondarily from extension of a peripancreatic pyemic abscess or other infectious inflammation in the neighborhood (ulcer of the stomach, retroperitoneal abscess, etc.).

Pancreatitis may be acute, subacute, or chronic. The **acute form** is usually ushered in by **sudden pain** in the upper abdominal region, accompanied by **collapse** and followed by **vomiting.** Obstipation is a prominent symptom and usually leads at first to a diagnosis of intestinal obstruction (Fitz). Diarrhea may follow if the patient survives. There is tenderness between the umbilicus and the ensiform cartilage, and distention in the same locality. The clinical picture is that of peritonitis in the upper abdominal region. Slight jaundice from associated catarrh of the bile-ducts is present. The facial expression is anxious. The temperature varies from normal to subnormal, or high. The pulse is rapid and small. The collapse may be followed by unexpected improvement; this alternation of collapse and improvement may be repeated several times in the individual case. Examination of the pancreas is impossible on account of the pain and tenderness. Delirium, followed by death at any time from the second to the fifth day, is the rule. **Subacute pancreatitis** follows the same general course, but has less pronounced characteristics as to collapse, swelling of the upper abdominal region, vomiting, and rapid and thready pulse. The temperature may be disproportionately high in its relation to the pulse. Diarrhea with fetid stools and the presence of pus and blood may follow the primary obstinate constipation. Abscess may develop with the formation of a tender tumor, which may either come to the surface, or burrow into either loin and finally form a perirenal tumor; the pus may follow the iliopsoas muscle; it may invade the peritoneal cavity, causing fatal septic peritonitis; or it may perforate into the stomach or intestines. Relief will follow for a time; relapse occurs, however, and the patient usually dies from septicemia. In **chronic pancreatitis** the changes are at first hypertrophic and later cirrhotic. It may be mistaken for cancer of the head of the pancreas and give rise to obstructive jaundice and other symptoms of gall-stones (Robson). In considering the diagnosis, which is always difficult, attention should be given to incomplete digestion of fat and starch and the existence of diabetes and fatty stools. **Disseminated fat necrosis** bears very much the same relation to disease of the pancreas as jaundice bears to lesions of the liver. Pancreatitis closely resembles perforating gastric ulcer. In the latter the tenderness on slight pressure is more marked and the abdominal rigidity more pronounced (Lund).

The treatment of inflammations of the pancreas and of their sequels is operative. The abdomen should be opened by a vertical incision through the right or the left rectus muscle, the site of the lesion searched for behind the stomach, and drainage instituted. Large drains of rubber tubing, surrounded by gauze and brought out of the operative wound, were employed successfully in two cases in the author's practice.

The **tumors of the pancreas** are either retention cysts or hydatid disease. Their removal is justifiable; the extirpation of the pancreas, or even of the cyst wall, is not necessary. The edges of the incised sac may be sewed in the abdominal wound if possible. Simple drainage with tubes and gauze led out of the abdominal wound must suffice, however, in most cases.

Pancreatic calculi may form and be embedded in the head of the organ or in one of the ducts. They may be reached through the second part of the duodenum by laying open the papilla and exploring the duct. The incision in the papilla does not require suturing; the anterior duodenal wound is to be sutured.

Carcinoma of the pancreas has not as yet assumed a position of sufficient importance to entitle it to discussion, except by the pathologist.

Paracentesis of the Peritoneal Cavity.—Puncture of the abdomen is a simple operation for the relief of accumulations of fluid in the peritoneal cavity. Inasmuch as these accumulations occur in connection with conditions which are themselves incurable, the operation is only of symptomatic importance. The fluid usually reaccumulates.

The place for the puncture must be selected with reference to the position of the intestinal coils. These float on the surface of the fluid, while the fluid sinks to the most dependent portion of the abdominal or the pelvic cavity.

The site usually selected is a point in the linea alba, half-way between the umbilicus and the pubic symphysis. The bladder is first emptied, and the trunk of the patient is partially raised in order to float the intestines to the upper portion of the abdomen. A small incision is made in the skin and the trocar and cannula are thrust into the abdomen. A many-tailed bandage, previously passed about the body, is gradually tightened as the fluid flows, in order to prevent syncope.

The operation of **peritoneal anastomosis,** suggested by Talma of Utrecht and first performed by Van der Meule (1889), has been performed for ascites arising from cirrhosis of the liver. It consists in securing the omentum to the parietal peritoneum, with the object of promoting adhesions between these structures. The blood-vessels which form in these adhesions assist in establishing a free collateral circulation between the portal system and the parietal vessels, so that the recurrence of the ascites is prevented (see page 44).

THE STOMACH AND INTESTINAL CANAL

INJURIES OF THE STOMACH AND INTESTINAL CANAL

Blows and crushing forces on the abdominal wall, such as are produced by a fall, a kick of a horse, by being run over, buried beneath a mass of earth, or crushed between the buffers or couplings of railway cars, may cause rupture of the stomach or intestines, particularly if these organs are filled with food or distended with gas. Injury of the small intestine may likewise occur from its being forced against the rigid spinal column by the vulnerating force. Injuries of these organs may also occur from indirect violence, *e. g.*, severe concussion of the body from falling from a great height on the pelvis, the knee, etc. Rupture may also occur during an act of vomiting in case of ulceration, particularly in the region of the cardiac orifice. Ruptures from contusions of the abdomen occur most frequently in the region of the pylorus and the greater curvature. Lavage in incompetent hands may produce rupture of the stomach. **Gunshot wounds** of the stomach are not very often observed. Of 3717 perforating wounds of the abdomen occurring during the Civil War, only 79 gunshot wounds of the stomach are recorded.

Ruptures of the intestine from blows on the abdominal walls or from indirect force occur most frequently in the neighborhood of the junction of the duodenum and jejunum, where the intestine is held more firmly in position by the ligamentum suspensorium duodeni of Treitz. The small intestine is more frequently injured than the large intestine, owing to the greater elasticity and thicker walls of the latter. When the large intestine is ruptured, the rupture takes place most frequently at its points of fixation, namely, the flexures.

Overdistention of the intestine with gas and feces occurring in connection with intestinal obstruction may cause rupture, particularly in case of pathologic changes, such as carcinoma. Gangrenous conditions following strangulation lead to rupture. Erosions and ulceration from pressure, or suppurative processes also produce ruptures. In **punctured** and **gunshot wounds** of the intestine the injured loop is sometimes prolapsed into the abdominal wound at the time of injury, and the cavity of the peritoneum escapes contamination. Prompt surgical assistance in these cases (suture and reposition) saves the patient. In the majority of cases this prolapse does not occur and septic peritonitis then proves quickly fatal. Occasionally, particularly in injuries caused by the modern small-bore and high-velocity rifle, a bullet may pass completely through a coil of intestine, and, in case the latter is empty and peristalsis is not excited, agglutination of peritoneal surfaces may seal the openings before infection of the general peritoneum takes place. Infection of the track of the wound may take place, however, and **fecal abscess** and **fecal fistula** follow.

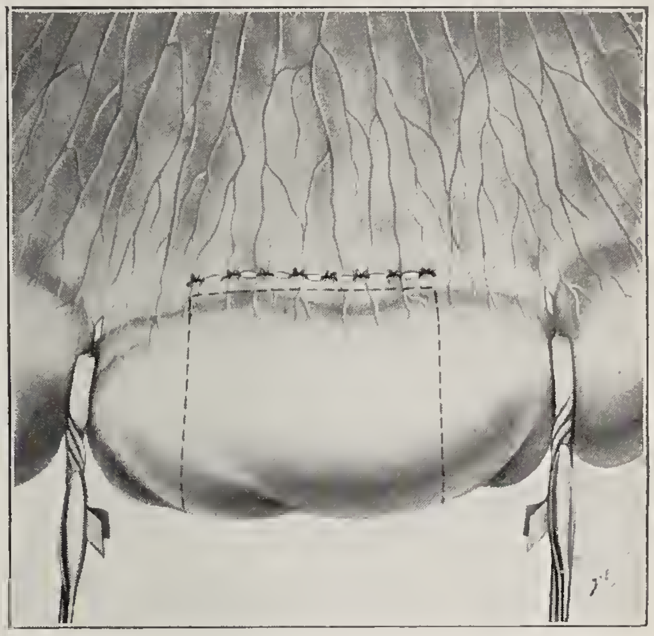

Fig. 420.—Resection of the Bowel.

A row of sutures is placed in the mesentery. The dotted lines mark the limits of the resection. A narrow strip of gauze is passed through the mesentery on each side of the point of proposed resection, and twisted sufficiently to occlude. The weight of the forceps that grasp the ends of the gauze strips prevents the latter from untwisting.

Injuries of the stomach and intestinal canal caused by **swallowing foreign bodies** are less dangerous. While rounded, smooth substances pass readily along the alimentary tract, pointed foreign bodies often invade the wall of the stomach, produce adhesive inflammation between the peritoneal layers, and finally appear beneath the skin in connection with an abscess, the abdominal cavity escaping infection. They may even find their way into the latter without causing serious results. In a case occurring in my hospital service a crochet needle four inches in length and one-eighth of an inch in diameter, having an ivory handle cemented on, had perforated the stomach and found its way into the peritoneal cavity without the handle, this having become detached by the solvent action of the gastric juice on the cement and having probably passed per anus. No inflammatory symptoms were present at any time. Instances are recorded in which patients swallowed large numbers of pins and needles, these appearing in various and remote regions of the body.

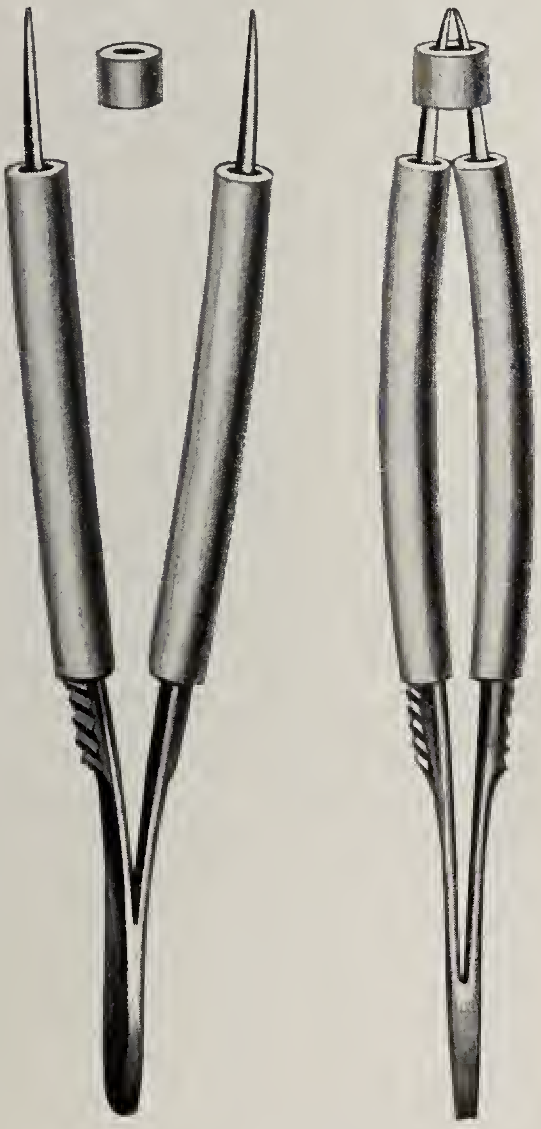

Fig. 421.—Maylard's Device for Employing Dissecting Forceps as Intestinal Clamps.

Treatment of Wounds of the Stomach and Intestines.—In cases of subcutaneous rupture and punctured and gunshot wounds of the stomach and bowels nothing short of the most prompt interference may save the patient. The abdomen should be opened in the median line and a careful search made for the site of the injury. The wound is repaired by suture and the abdominal cavity carefully cleansed. Delay not only imperils the patient's life by permitting infection to take place from the extravasated contents of the stomach or bowel, but renders the operation more difficult, owing to the presence of distended coils of intestine.

Suture of the bowel or **enterorrhaphy** was formerly performed almost exclusively when injured loops of intestine prolapsed through the abdominal wound, and the surgeon had to deal usually with transverse and horizontal wounds at the convexity of the bowel. Complete transverse separation of the bowel is rare in injuries, but is typic in cases of resection, *e. g.*, for carcinoma of the intestine, gangrene, etc.

On opening the abdominal cavity the injured loop of intestine is isolated and emptied, fecal matter being prevented from re-entering it by intestinal clamps or by a strip of gauze passed through the mesentery, grasped by an artery clamp and twisted until occlusion is secured (Fig. 420); the weight of the clamp prevents untwisting; or Maylard's device for employing dissecting forceps as clamps may be used (Figs. 421 and 422). Special instruments have been devised for this purpose (see Fig. 433). The entire remaining portion of the abdominal cavity is walled off by gauze pads. If resection is necessary, a row of sutures is placed in the mesentery about half an inch from the intestinal margin to secure the vessels, and the gut is detached and resected (Fig. 420). It is not necessary to remove a V-shaped piece of the mesentery, the surfaces of the redundant fold being subsequently lapped and stitched (Fig. 423).

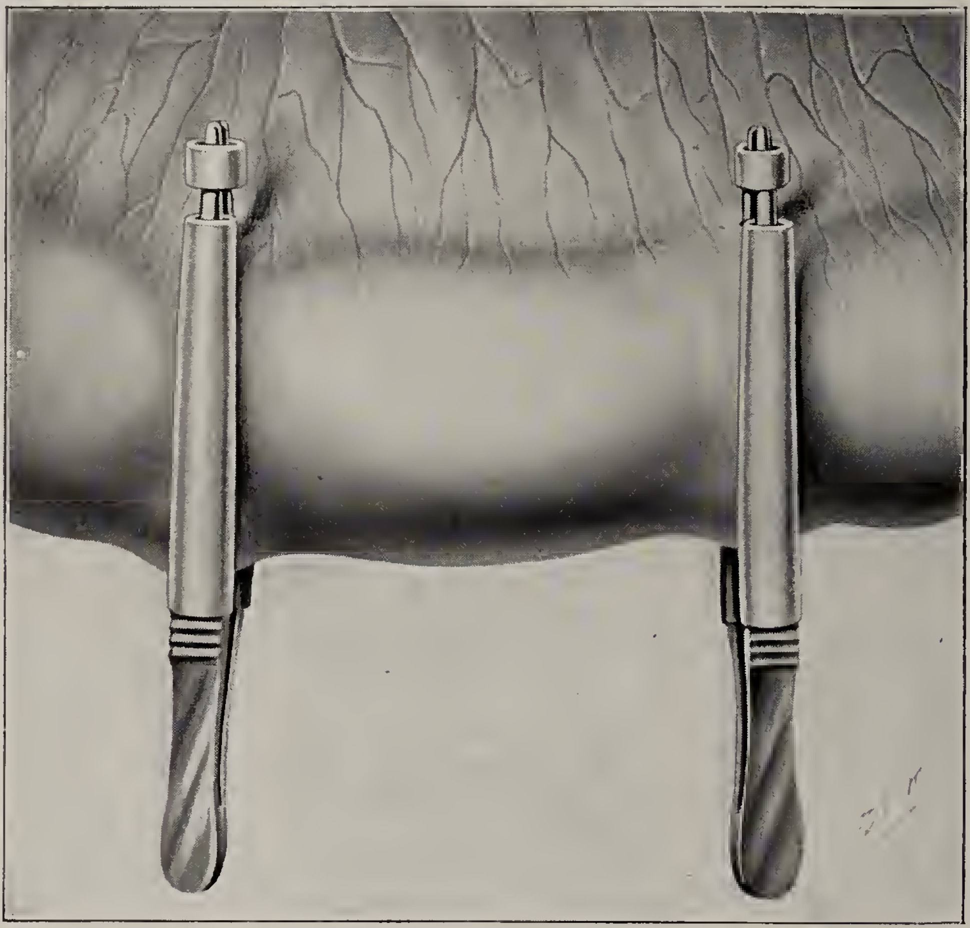

FIG. 422.—MAYLARD'S DEVICE FOR EMPLOYING DISSECTING FORCEPS AS CLAMPS. APPLIED.

The oldest intestinal suture, the **suture of the Four Masters** (so called by the Venetian School, 1520), consisted essentially of suture of the wound edges, as in sutures of the skin, the intestinal tube being steadied by the introduction of a cardboard cylinder, or the trachea of a goose or calf.

An improvement in 1846 consisted in cutting away the projecting edge of the mucous membrane (Duverger) so as to avoid prolapse of the latter into the suture line. The unstable character of this suture in resisting pressure from within the bowel led to the search for a suture that would bring broader surfaces in contact. This was possible only by including in the suture the serous covering of the bowel. Such a suture was introduced in 1826 by Lembert, who took advantage of the knowledge possessed by the older surgeons. **Lembert's suture** is today the most important feature of enterorrhaphy. It is now applied in such a manner that the needle enters the serosa at about one-fourth of an inch beyond the wound edge, includes the entire thickness of the bowel wall except the mucosa, and emerges at about one-eighth of an inch from its point of entrance (Fig. 424). This is repeated on the opposite side of the wound, the needle entering about one-eighth of an inch from the edge of the wound in the intestine and emerging at a point one-eighth of an inch from the point of entrance. The sutures are placed about one-eighth of an inch apart. They may be interrupted, as originally applied, or, as now preferred by many, a continuous suture may be used.

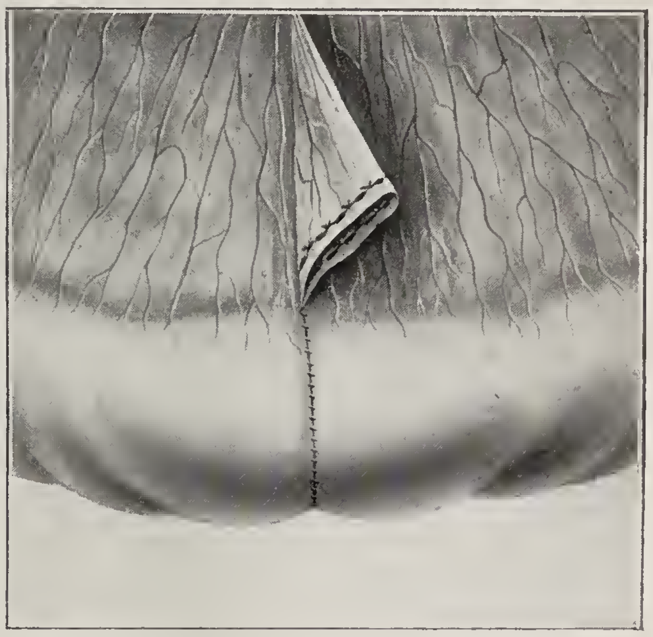

Fig. 423.—Resection of the Bowel. The ends of the bowel united, the occlusion bands removed.

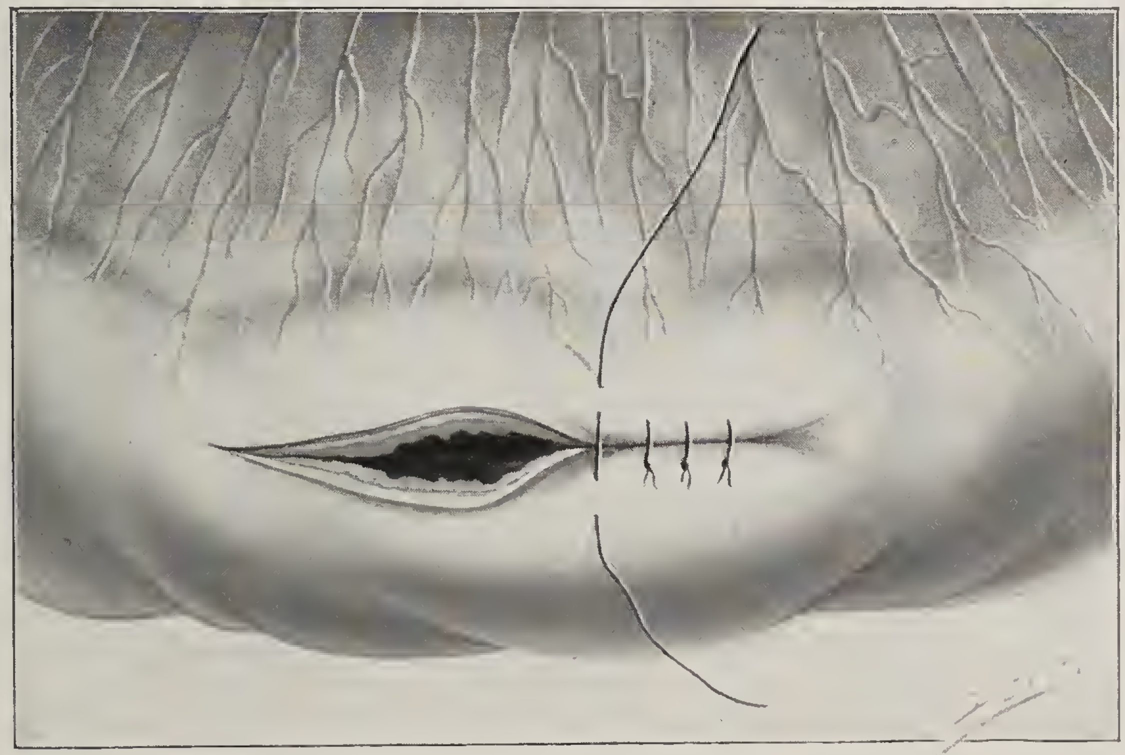

Fig. 424.—The Lembert Suture.

The weak point in the Lembert suture is the fact that the loop which grasps the intestinal wall and the line of traction of the suture pass practically in the same direction as the blood-vessels and circular muscular fibers, the thread thereby meeting with comparatively slight resistance in cutting its way out when tension is applied. In order to increase this resistance a continuous Lembert suture should be applied in such a manner that the loop of the thread corresponds to the long axis of the gut (Figs. 425 and 426).

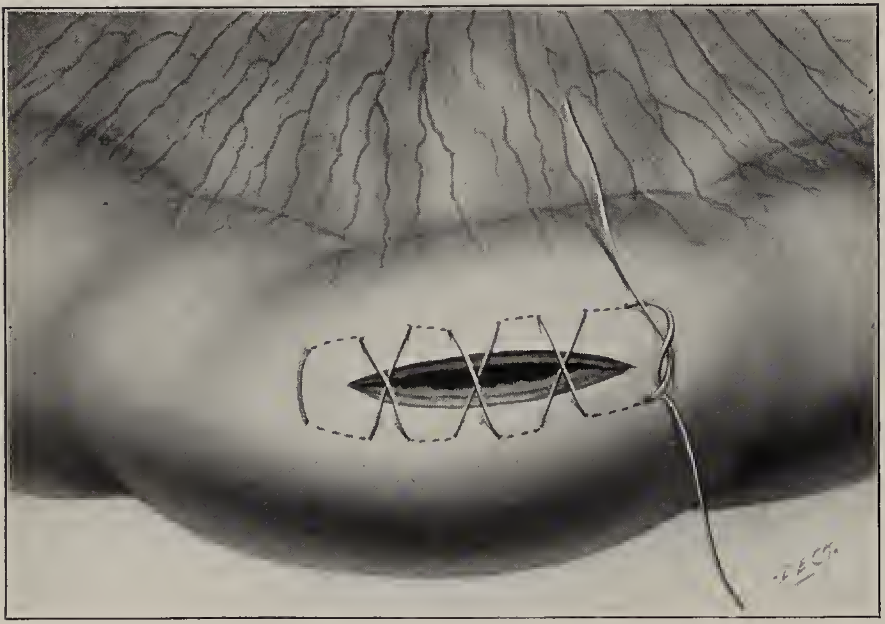

FIG. 425.—GELLY'S SUTURE.
In this method the suture is first applied in its entirety. The loops are then drawn taut singly so as accurately to approximate the serous surfaces, and finally secured by tying the ends.

In **total transverse ruptures of the bowel,** as well as in **resection,** end-to-end approximation may be employed. The simplest method is to approximate the serous surfaces near the open ends of the gut to each other and apply a row of interrupted mattress sutures from the interior of the intestine, including all its coats (Figs. 427 and 428). These sutures are knotted inside. In order to insure this, when the row is nearly completed, the last one or two sutures are passed in the same manner as the others, *i. e.*, so as to bring their ends inside. These ends are now threaded on a needle and the latter passed, eye first, between two sutures on the opposite side of the bowel (Fig. 429). The suture is now tied, the knot slipping readily into place (Fig. 430). A second row of Lembert sutures may be applied around the circumference for increased security. In order to insure contact of corresponding points of the intestine, a suture is first applied at the mesenteric attachment and its ends left long temporarily for convenience when the parts are steadied by an assistant; a second similar suture is applied at the convexity of the bowel directly opposite the first. In this way the circumference of the bowel

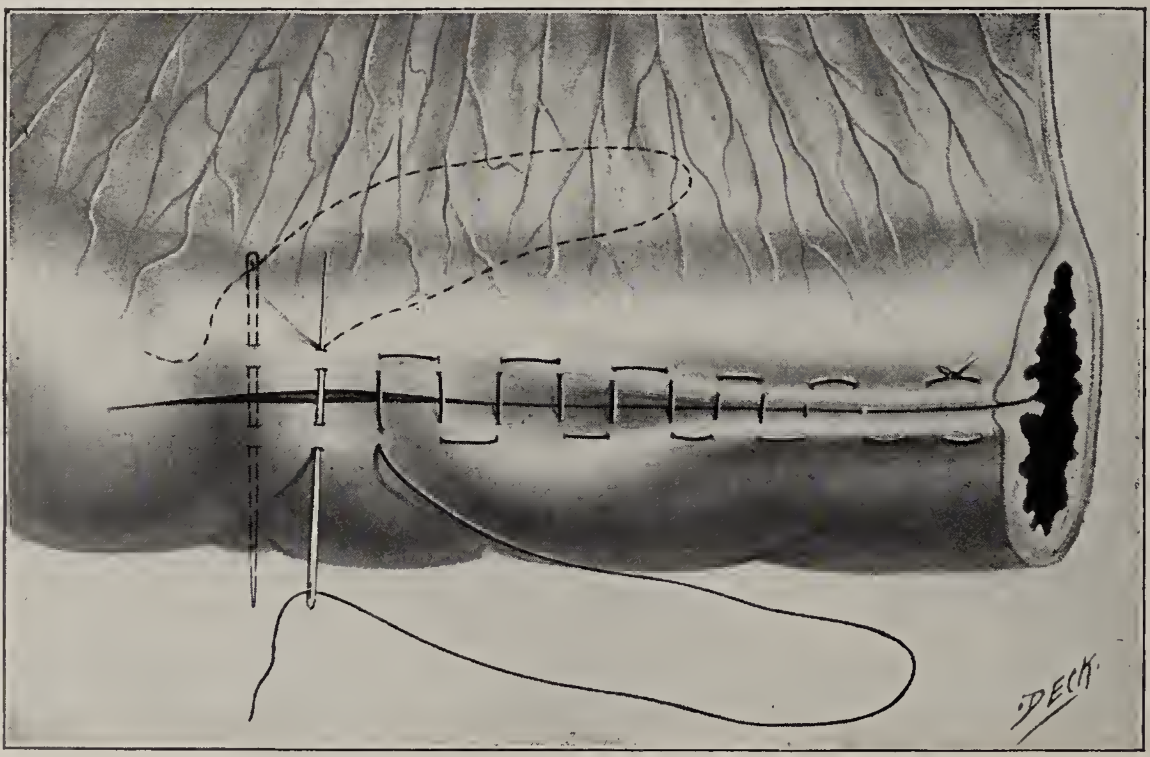

FIG. 426.—THE AUTHOR'S INFOLDING INTESTINAL SUTURE.
The first two sutures are drawn taut so as to make close approximation. The remaining sutures are left loose to show the progressive infolding of the wall of the intestine.

is divided into two equal parts (Fig. 428, Connell's method modified). Or, Wölfler's simple through-and-through suture may be applied (Fig. 431).

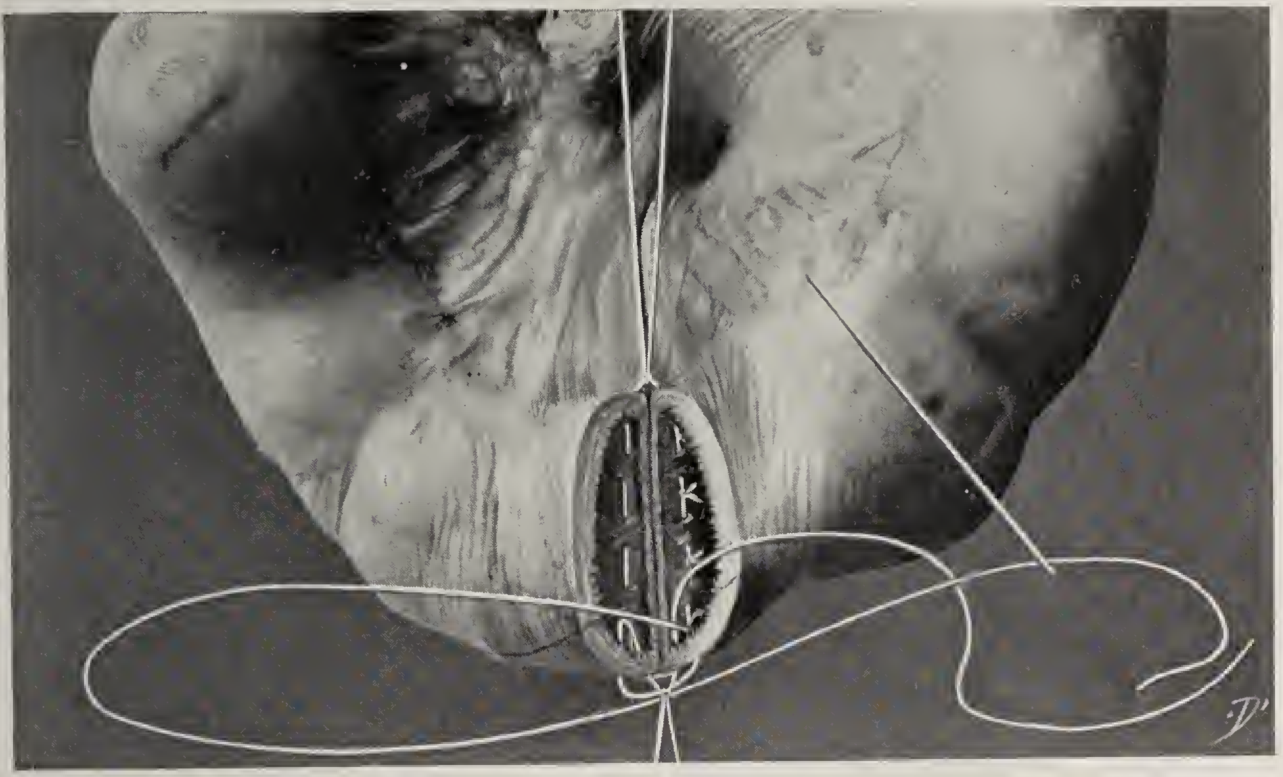

Fig. 427.—"Knots All Inside" Suture of the Bowel. The mattress sutures in course of application.

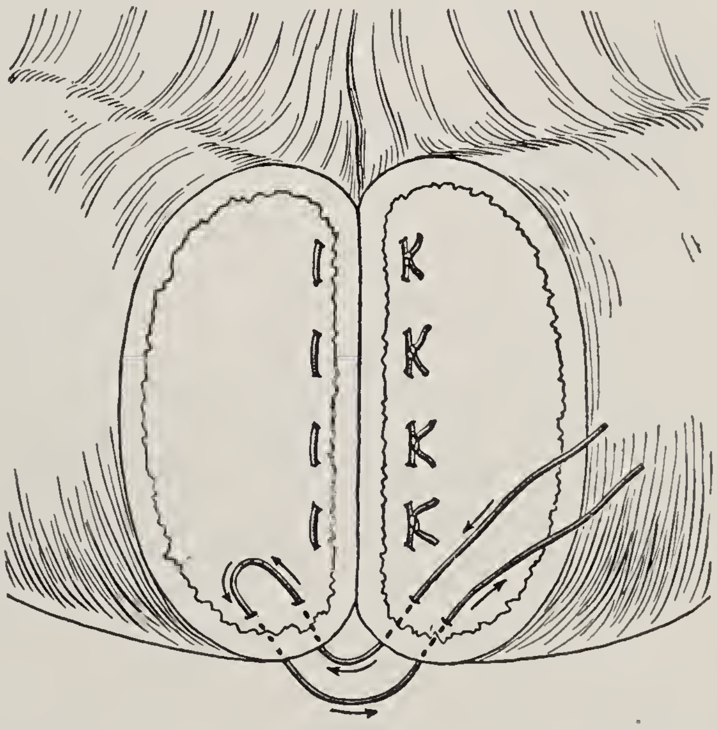

Fig. 428.—"Knots All Inside" Suture of the Bowel. The arrows show the direction in which the suture is applied.

Rapid approximation after resection may be obtained by the use of the **Murphy button.** The button itself is of metal, made in two parts, in one of which the pressure of the impinging edge is applied by means of a spring. A running suture, including the whole thickness of the intestine, holds each half of the button in the opening of the corresponding segment, and when the two ends are approximated and the parts of the button coupled firmly, a diaphragm of tissue in two layers, one from each end of the intestine, is formed, with serosa to serosa (Figs. 433, 434, and 435). This diaphragm is separated finally by a sloughing process from the continuous pressure of the spring within the button and comes away in the grip of the latter. In applying the running suture in the bowel ends, the first stitch includes both layers of the mesentery at its attachment to the bowel and must pass twice through the layers (backstitched) in order to insure against leakage at this point. The bowels are to be kept in a fluid condition from the first by the administration of a dram of sulfate of magnesium three or four times a day. The button comes away *per rectum* in from ten days to six weeks. In order to do away with the necessity for the expulsion of the button the latter may be made of magnesium, which undergoes disintegration in the intestines (Chlumsky).

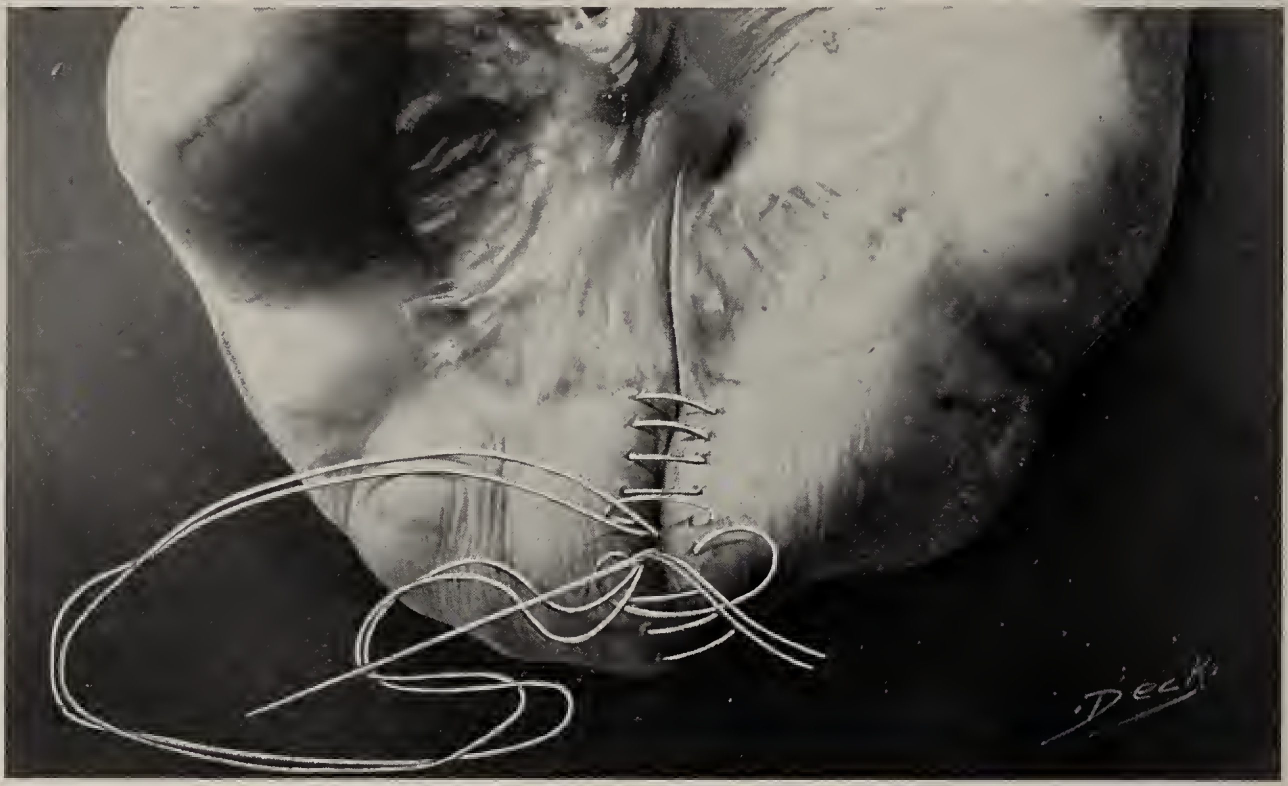

Fig. 429.—"Knots All Inside" Suture of the Bowel.
Manner of passing the free ends of the last suture to the opposite side of the bowel in order to secure the knot on the inside.

The too early sloughing of the diaphragm before proper adhesions have formed externally, and consequent leakage, or lodgment of the metal button at a point lower down in the intestine, have been urged as objections to the use of the Murphy button. In addition, it is necessary to keep the contents

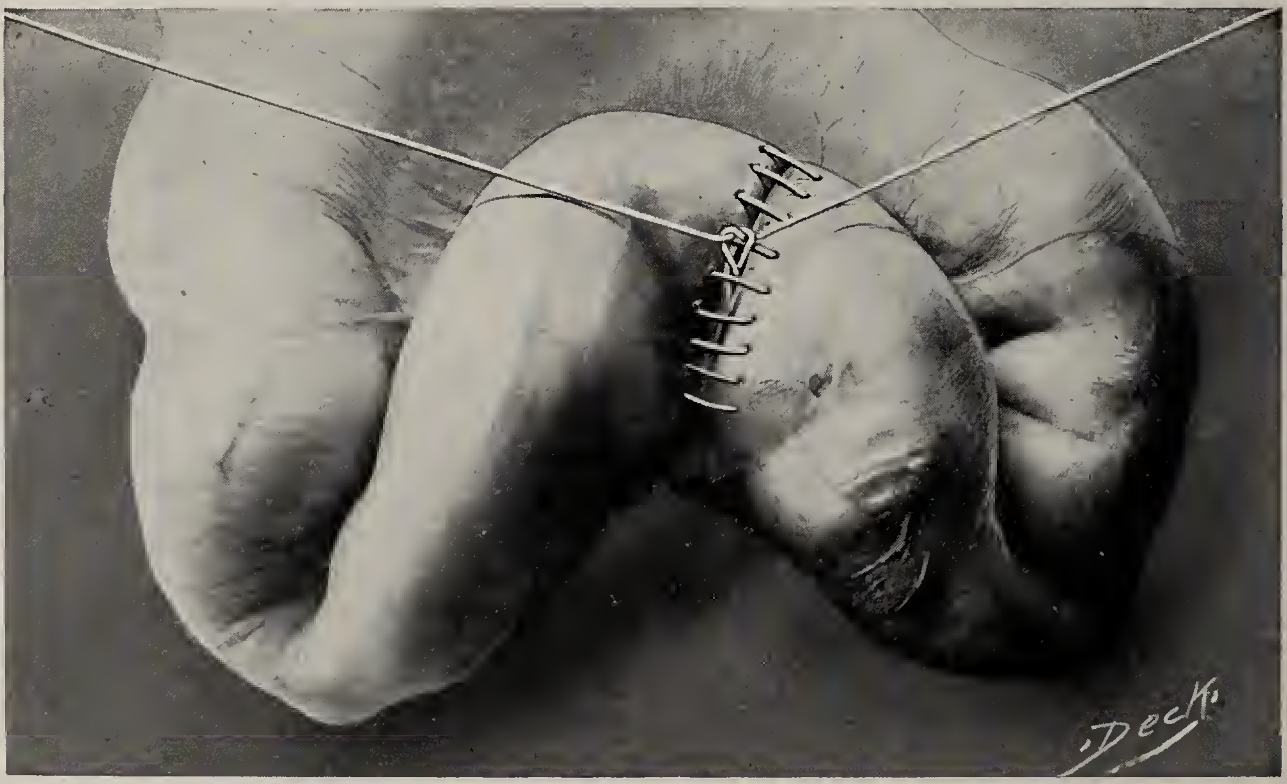

Fig. 430.—"Knots All Inside" Suture of the Bowel.
Showing the last suture as it is tied upon the opposite side of the bowel, the knot disappearing inside the latter.

of the bowels in a fluid condition by salines, on account of the small opening in the button. The peristalsis thus excited adds a further danger to the operation.

Senn's method by bone plates makes intestinal anastomosis by lateral approximation somewhat safer than the end-to-end anastomosis button of Murphy, but it cannot be applied so rapidly and is limited in its application. The plates must be prepared beforehand and kept ready for use, and their double-threaded needle arrangement makes the method inconvenient and sometimes complicated in the hands of those who are called on to operate in an emergency, and who are not accustomed to its use. The vegetable plates of Dawbarn, as well as the vegetable oval bobbin, possess an additional advantage in that they may be efficiently improvised for an emergency by the surgeon himself.

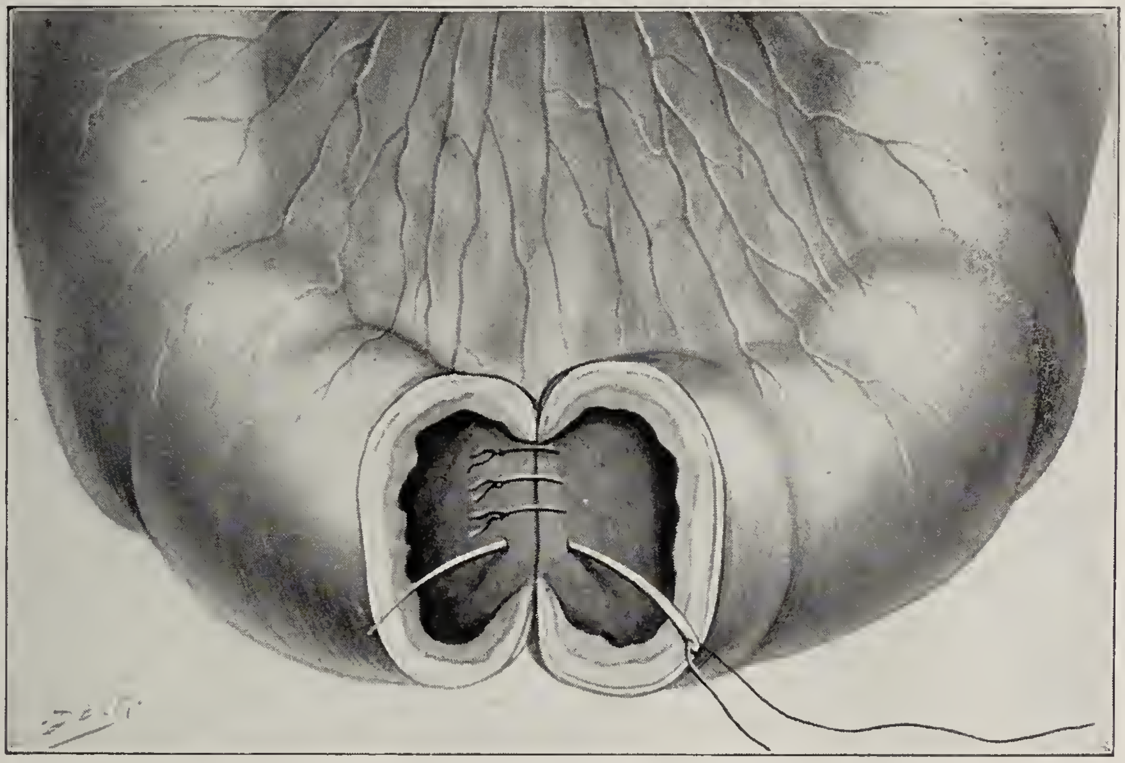

Fig. 431 —Wölfler's Suture.

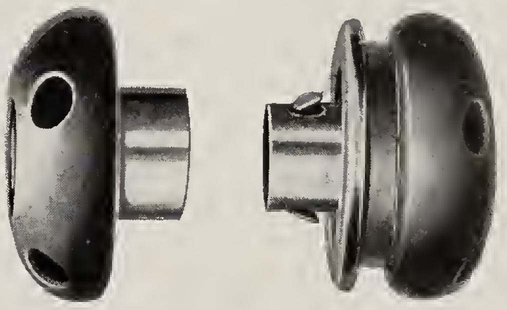

Fig. 432.—Murphy's Anastomosis Button.

Horsley's method of end-to-end approximation provides a greater diameter for the sutured portion than that which is normal to the intestine. The ends of the bowel are placed side by side with the openings in the same direction and are held in this position by a clamp (Fig. 437). The septum thus formed is cut away and its edges sutured. On the completion of this stage of the operation the suture is continued as an invagination suture, which completes the approximation (Fig. 438).

Lateral approximation, or **lateral enterorrhaphy,** is secured after resection by first closing the ends of the intestine by means of an invaginating pursestring suture (Fig. 439). A stitch or two is taken after invagination to secure the latter. The two segments are laid side by side in the position which they are to occupy when the approximation is completed, and a line about two inches long is scratched with the point of a needle in the serosa of each segment to mark the site of the intended opening. A running suture of silk, which includes all the coats except the mucosa, is to be placed so as to connect the margins of the adjacent surfaces between the scratch line and the adjoining free margins of the intestine. The openings are now to be made and the edges of the incised mucous membrane which lie nearest each other, *i. e.*, on the posterior aspect, included in a running suture similar to the first; the needle is to be retained and both ends of this, as well as the first suture, left long. An oval-shaped vegetable bobbin, made of either a turnip or a potato, dipped in hot paraffin to sterilize its exterior, and corresponding in size to the requirements of the case, is now introduced, each of its flanged portions lying in the corresponding segment of intestine and its groove corresponding to the edges of the openings in the intestine (Fig. 440). The mucous membrane running suture is now completed anteriorly and tied tightly about the bobbin, which is prevented from collapsing under the pressure of the including suture by its oval shape. The first or seromuscular suture is now completed anteriorly and likewise tied about the bobbin (Fig. 441). The ends are cut short and a few drops of Wölfler's mixture applied along the suture line.* The constricting strips of gauze are now removed and the intestine replaced.

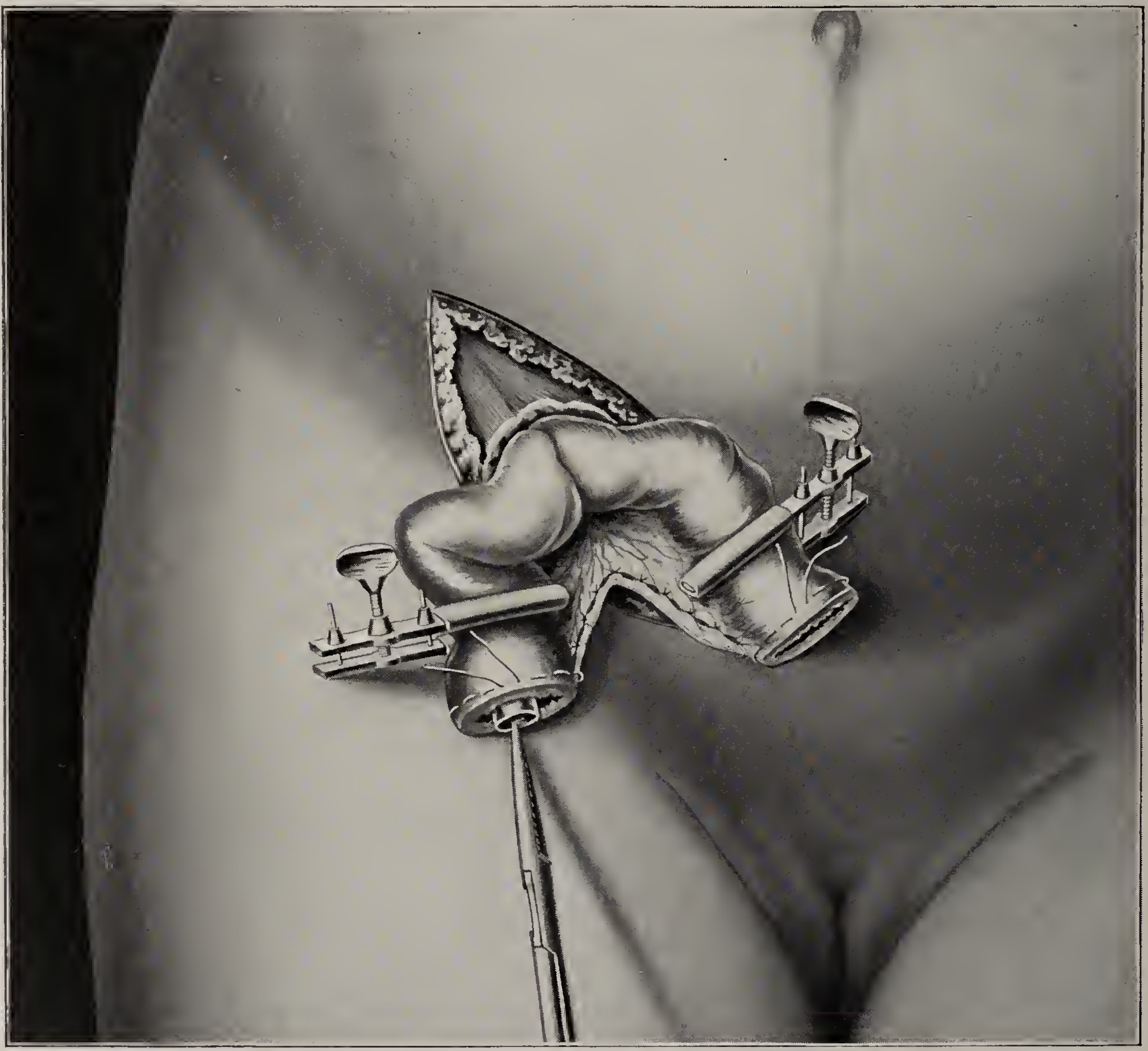

FIG. 433.—APPLICATION OF THE MURPHY BUTTON.
The pursestring suture applied and one of the halves of the button in place.

In all cases of doubt as to freedom from tension at the site of the enterorrhaphy a small safety drain of gauze should be led from the site of the sutured intestine through the abdominal wound. This may be removed after five or six days.

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* Wölfler's mixture is a peritoneal varnish made by dissolving mercuric chlorid in compound tincture of benzoin (1 : 2000) and adding ten per cent of iodoform.

In cases of **gunshot wounds of the mesentery** near the bowel wall, the portion of intestine corresponding to the injured spot in the mesentery must be resected. The peculiarity of the blood-supply of the wall of the intestine is such that a definite area of the latter is liable to gangrene in such injuries.

In all methods of intestinal suture, with the exception of that by the Murphy button, **peristalsis is to be avoided** by withholding ingesta as much as possible for the first week and administering small doses of opium to restrain that which occurs from nourishment necessarily given. If the patient is fed by the rectum, in case of suture of the small intestine there is comparatively little, if any, peristalsis excited in the latter. On the other hand, if the large bowel has been sutured, feeding by the rectum must be avoided and milk and eggs given by the mouth.

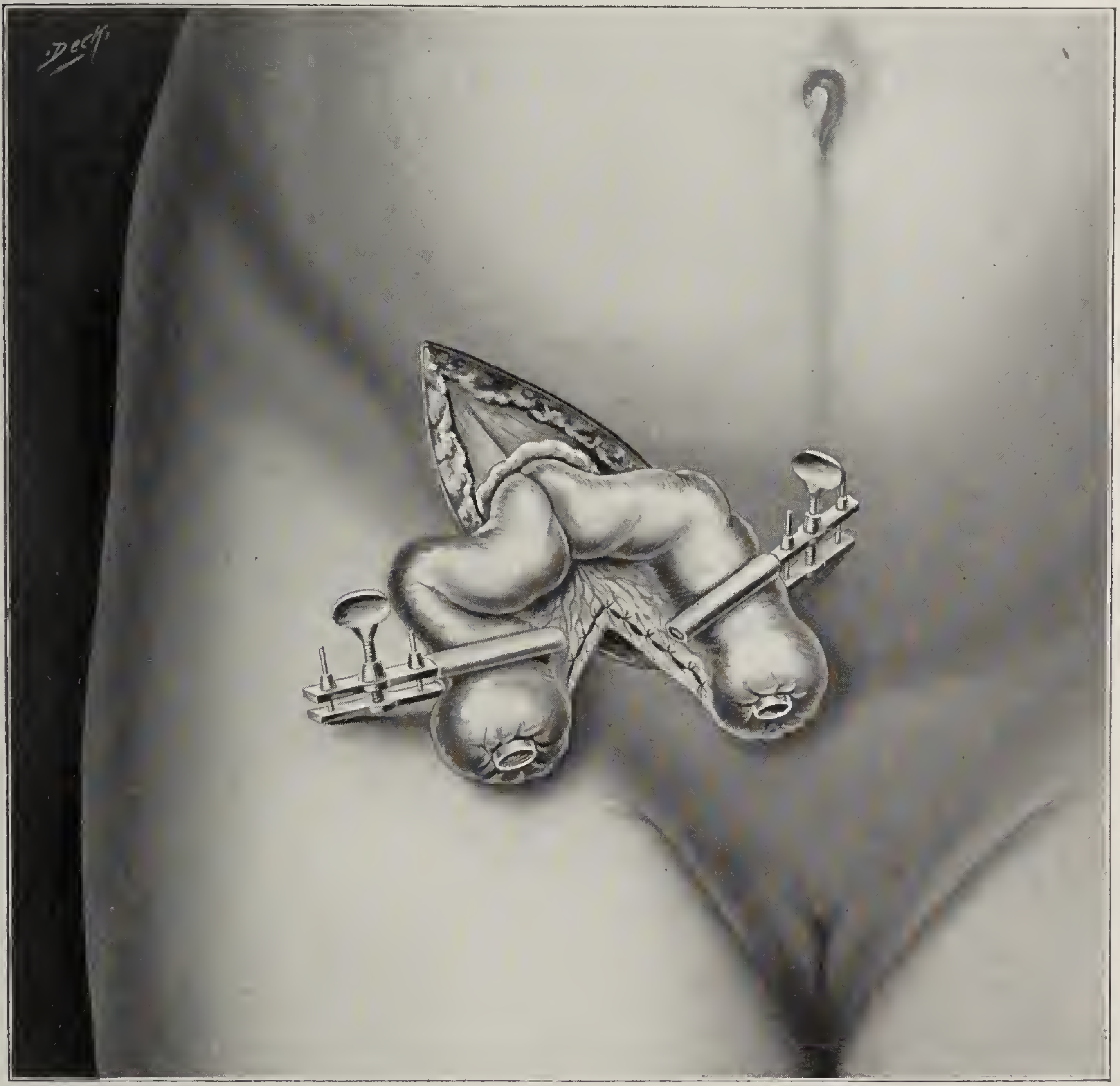

Fig. 434.—Application of the Murphy Button.
Both halves of the button in place and the pursestring sutures tightened and secured by tying.

The **indications** for resection of the bowel, or enterectomy, aside from injury, are as follows: (1) gangrene of a strangulated intestinal loop (Randolph, 1727); (2) malignant tumors of the intestine (Reybard, of Lyons, 1833);

(3) the cure of artificial anus, or anus preternaturalis (Kinloch, of South Carolina, 1863); (4) operative injuries, accidentally occurring in the course of the removal of abdominal tumors and due to attempts to separate adhesions, and also in cases in which the latter compel methodic removal of a portion of the bowel wall.

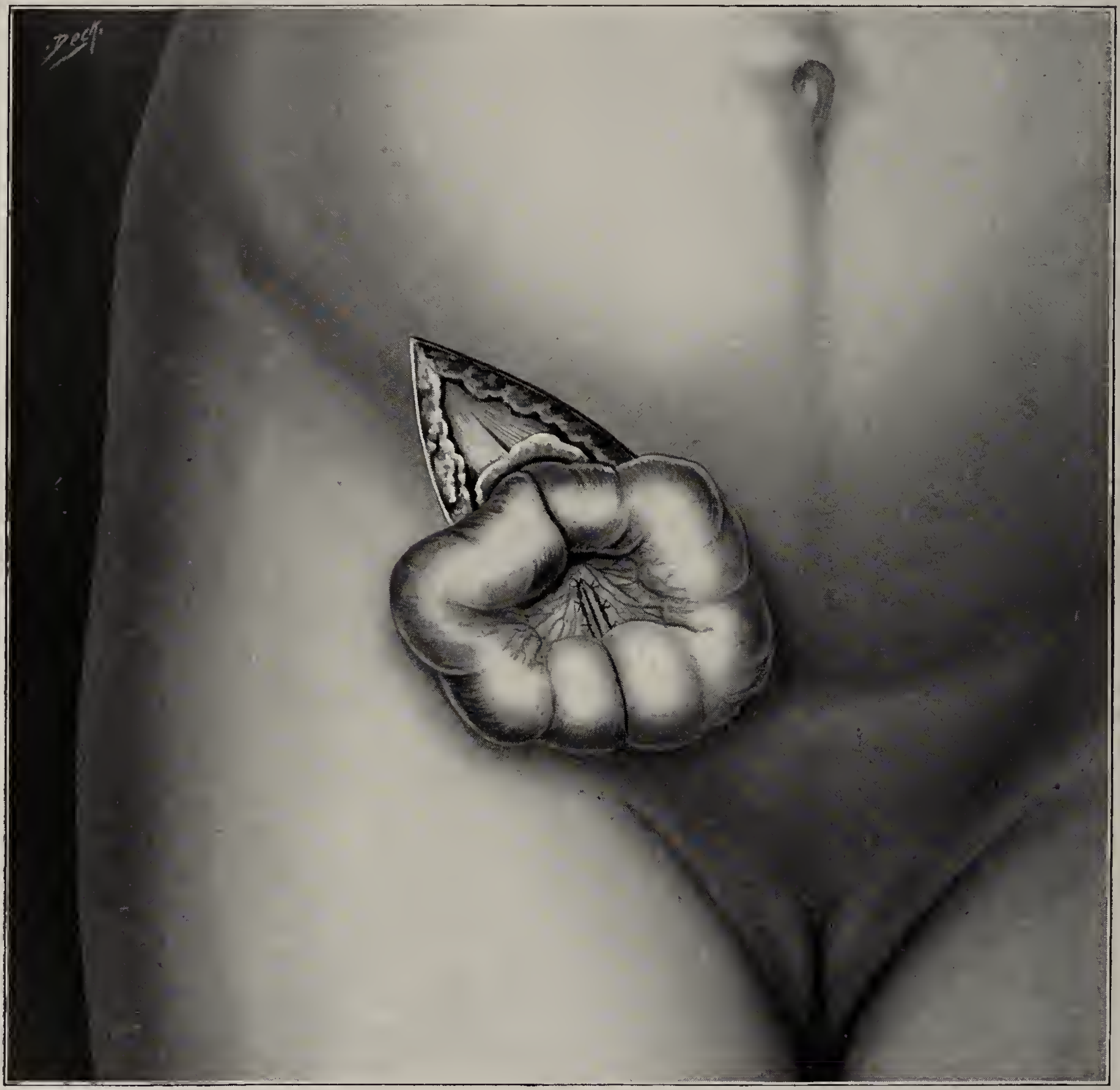

FIG. 435.—APPLICATION OF THE MURPHY BUTTON.
The ends of the bowel brought in apposition and secured by coupling the two halves together.

Gunshot and other wounds of the stomach are to be treated on the same general principles as those of the intestinal canal. The stomach must be kept at rest for a number of days and **nutrient enemas** given. In case of injury near the duodenal junction, with a probability of **stenosis of the pylorus** in the future, the operation of posterior gastroenterostomy should be performed.

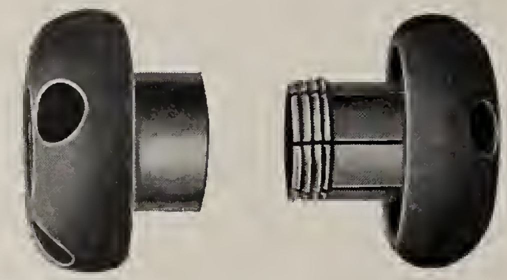

FIG. 436.—CHLUMSKY'S MAGNESIUM INTESTINAL BUTTON.

Gastric fistulas some times result from injuries of the stomach. These should be treated by abdominal section, separation of the adhesions, and suture of the opening in the stomach (Billroth, Esmarch).

TUMORS OF THE INTESTINAL CANAL

Papillomatous and polypous proliferations of the mucous membrane of the intestine, except those which are observed in the anorectal region, are of but slight surgical importance. **Malignant tumors** of the intestine are most frequently observed in the shape of **adenocarcinoma** and **colloid cancer.**

Carcinoma of the Intestine.—Carcinoma of the intestine occurs as a hard and usually circular mass in the mucous membrane. Extension as a rule takes place peripherally with respect to the free surface of the growth, until a thick circular induration surrounds the tube, which finally becomes obstructed, partially by the proliferation of the growth and partially by the constriction which the latter exercises. In cases in which obstruction is delayed, the growth is found to have infiltrated the submucous connective tissue and the muscularis, as well as the peritoneal coat, and to have involved the adjacent parts, peripheral extension on the mucous membrane being wanting.

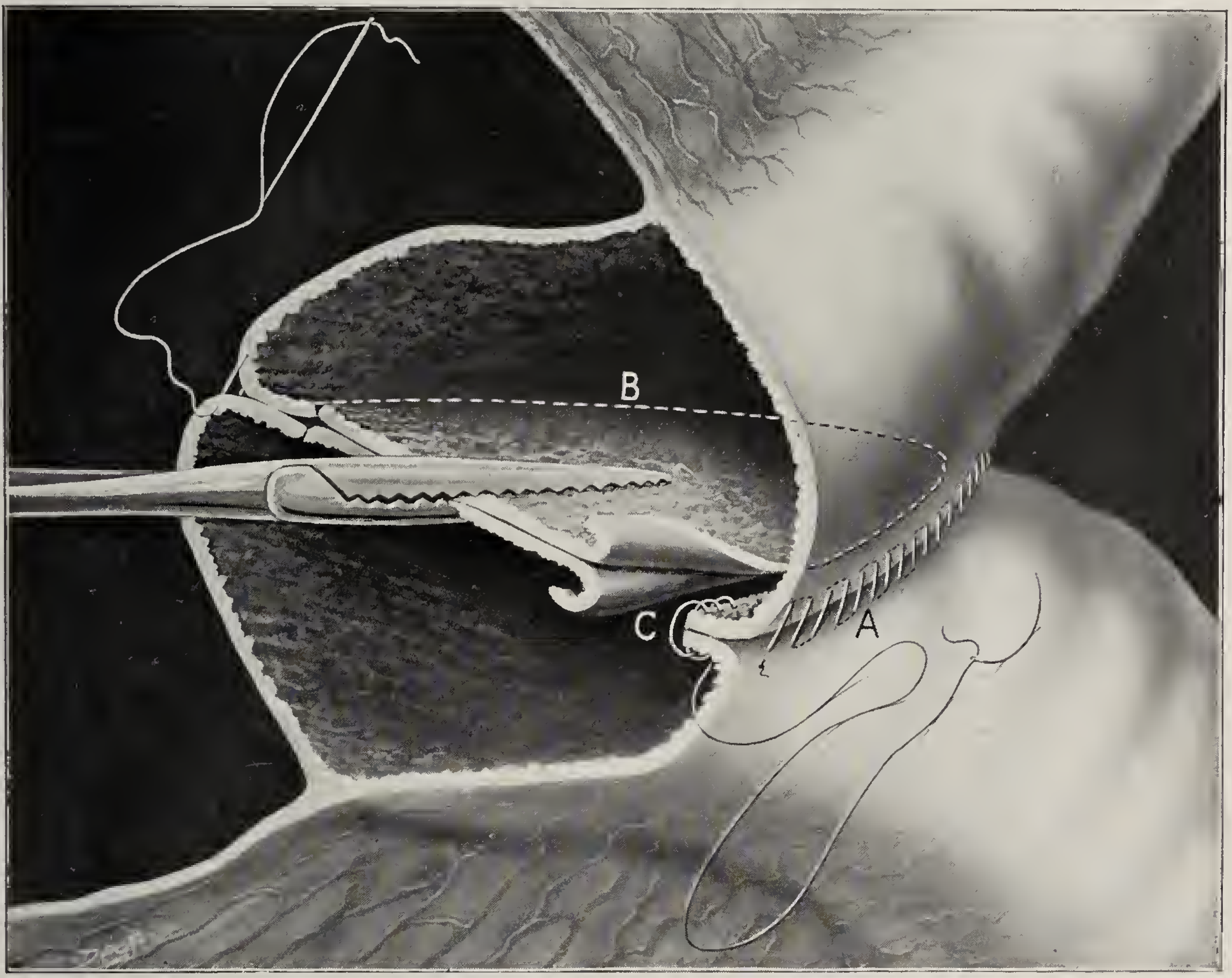

Fig. 437.—Horsley's Method of Enterorrhaphy.

The two ends of the intestine are placed in position and grasped by an artery clamp. The external or sero-muscular suture, "A," has made one-half of the circuit of the line of approximation. The dotted line "B" shows the line of section for the removal of the septum. At "C" is shown the septum partly cut away and the internal or overhand suture uniting the entire thickness of the intestinal wall when the "shelf" is formed.

The disease usually occurs from the fortieth year to the extreme limit of life. It is comparatively rare before thirty; in a case coming under my care in the Methodist Episcopal Hospital the disease was present in the cecum of a young man of twenty-six. About 75 per cent of the cases occur in the rectum, 23 per cent in the large intestine exclusive of the rectum, and 2 per cent in the small intestine.

Sections taken from intestinal carcinoma show it to be made up of glandular recesses, lined with tall columnar cells supported by a dense connective-tissue stroma, the proportion of which varies greatly. Lymphoid tissue is occasionally found to be present. When the section is made from the mucous membrane alone, the appearances under the microscope greatly resemble those of adenoma and differentiation is almost impossible. In carcinoma, however, the glands with their characteristic cells are found in the muscular fasciculi of the intestinal wall.

The retroperitoneal lymphatic glands are involved and dissemination is often widespread. Secondary deposits are formed in the liver, lungs, kidneys, and bones.

Symptoms.—The early symptoms include constipation, which sometimes alternates with diarrhea, and the discharge of small crumbling masses of feces. The disease is insidious in its development and progress, and frequently an attack of intestinal obstruction supervening on a condition of chronic constipation first calls attention to its existence. Localized pain and obstipation, combined with progressive loss of weight, in a person in the cancerous age will sometimes lead to an investigation which reveals the existence of a movable abdominal tumor connected with the large or small intestine, or of a hard mass high up in the wall of the rectum. In the case of the latter, particularly when the disease is situated low down, there may have been some warning symptoms, such as painful and obstructed defecation, hemorrhage, and the presence of a foul discharge.

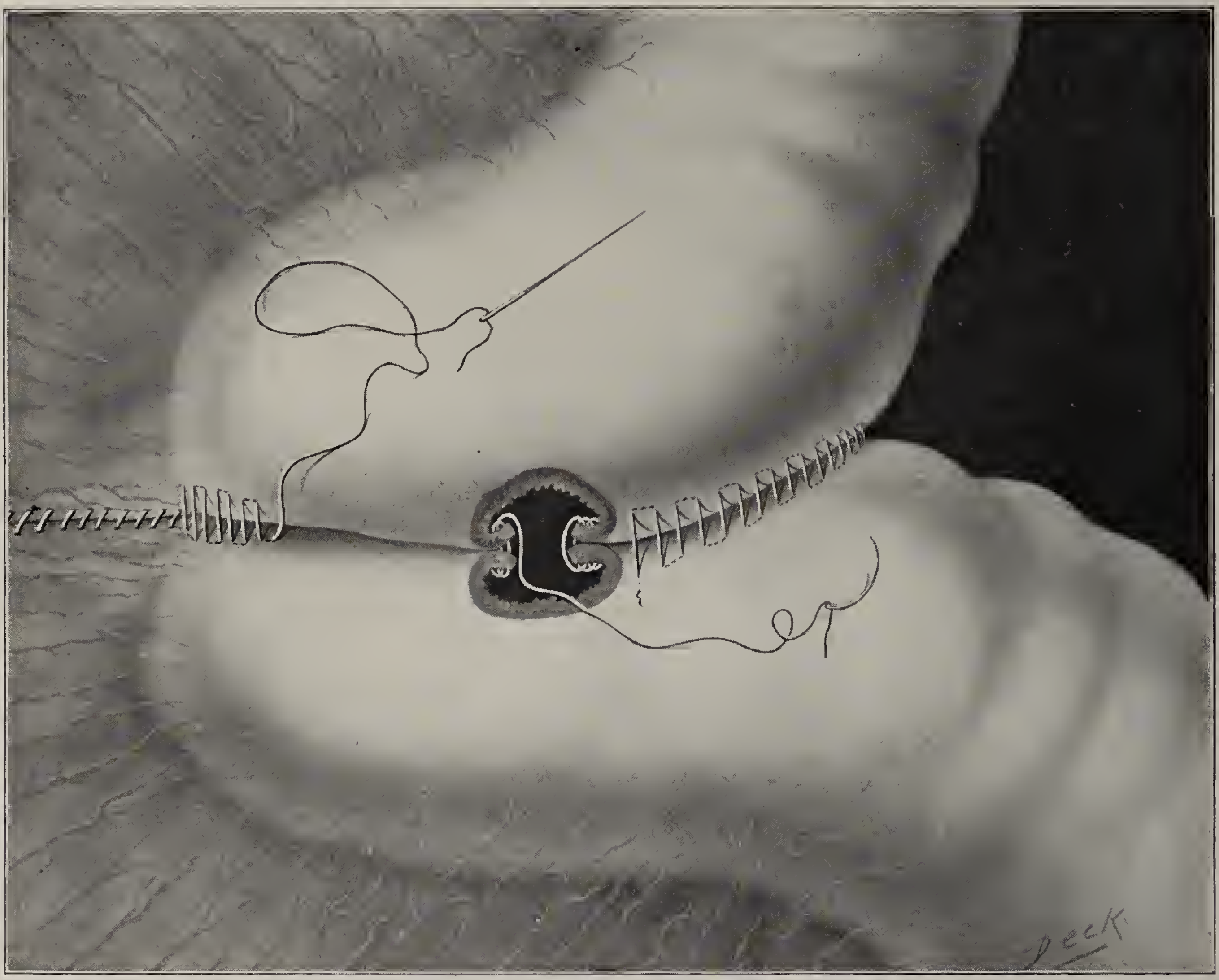

Fig. 438.—Horsley's Intestinal Anastomosis.
The septum has been removed, the row of internal or overhand sutures nearly completed, and the line of external or sero-muscular sutures in course of completion.

Diagnosis.—If the tumor is discovered early, it is usually distinctly outlined in connection with the bowel. Marked mobility is a characteristic of an intestinal tumor. Differentiation from omental tumors is difficult; the latter, however, usually have their origin in the bowel. Adhesions to the parietal

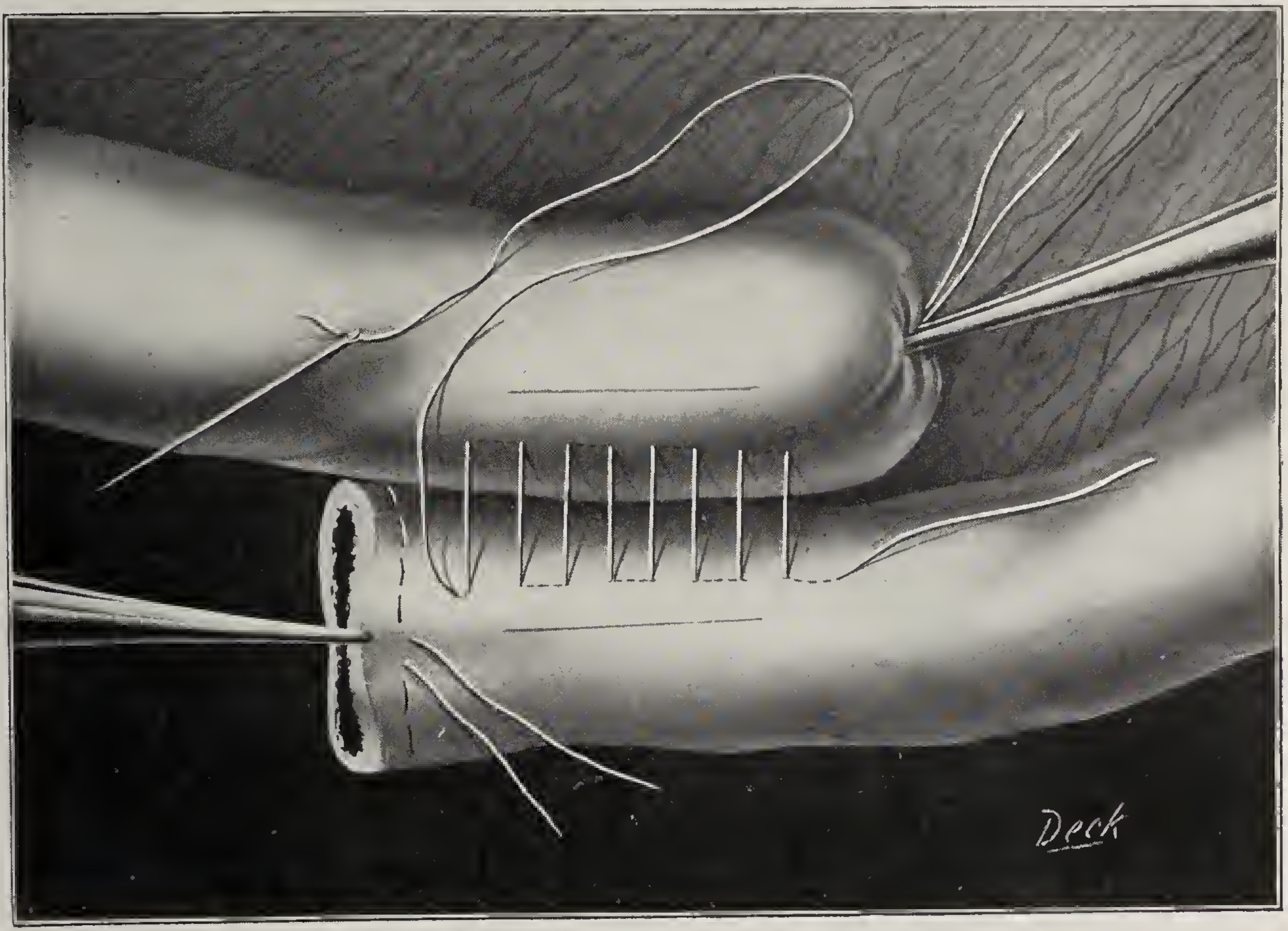

Fig. 439.—Lateral Enterorrhaphy.

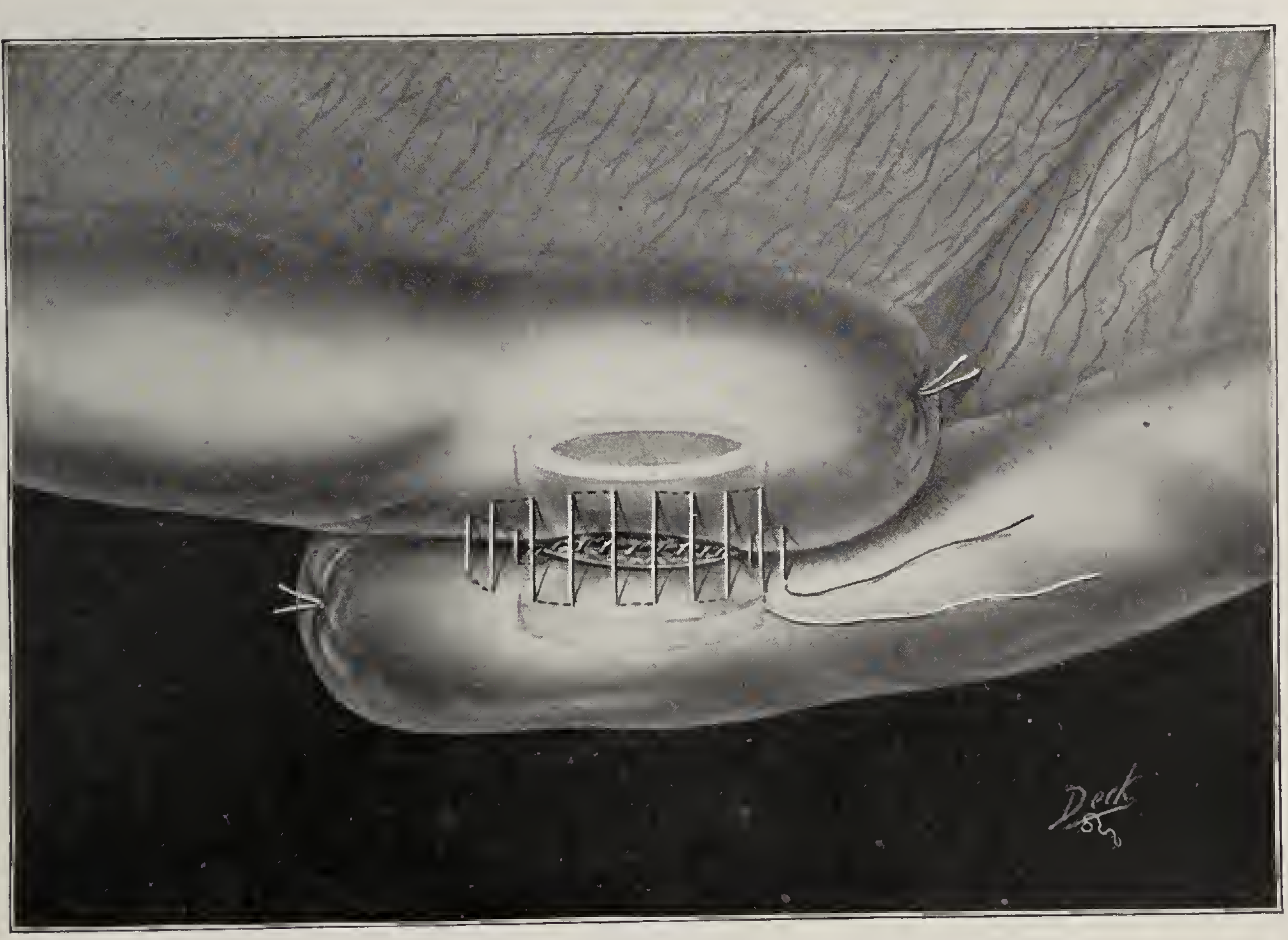

Fig. 440.—Lateral Enterorrhaphy with Vegetable Bobbin.
The bobbin is in position and the last line of sutures ready for drawing taut.

peritoneum and involvement of the abdominal wall may likewise obscure the diagnosis, the growth simulating sarcoma of the abdominal wall. The differential diagnosis of carcinoma and **impacted feces** is usually cleared up by the effect of a brisk purgative. In the later stages of carcinoma **progressive loss of weight and strength** and **cachectic anemia** are present, and finally obstruction to bowel movements (**complete coprostasis**) supervenes. The diagnostic points are the following: (1) the age of the patient; (2) constipation, followed by obstipation, and finally by obstruction; the last named comes on gradually, and in the absence of tumor or stricture of the rectum is due, in the large majority of cases, to intestinal carcinoma; (3) the presence of a movable tumor having its origin in the abdominal cavity; (4) progressive loss of weight and strength and the presence of cachectic anemia.

Prognosis.—In cancer of the small intestine death takes place from intestinal obstruction, arising either from coarctation of the lumen of the gut, intussusception into a dilated portion of the gut above, or angulation from adhesions. Fatal peritonitis may take place from perforation into the peritoneal cavity. Suppurative nephritis may carry off the patient in rectal cancer involving the ureters. In otherwise inoperable cases life is sometimes prolonged and made more endurable by an artificial anus (**inguinal colostomy**).

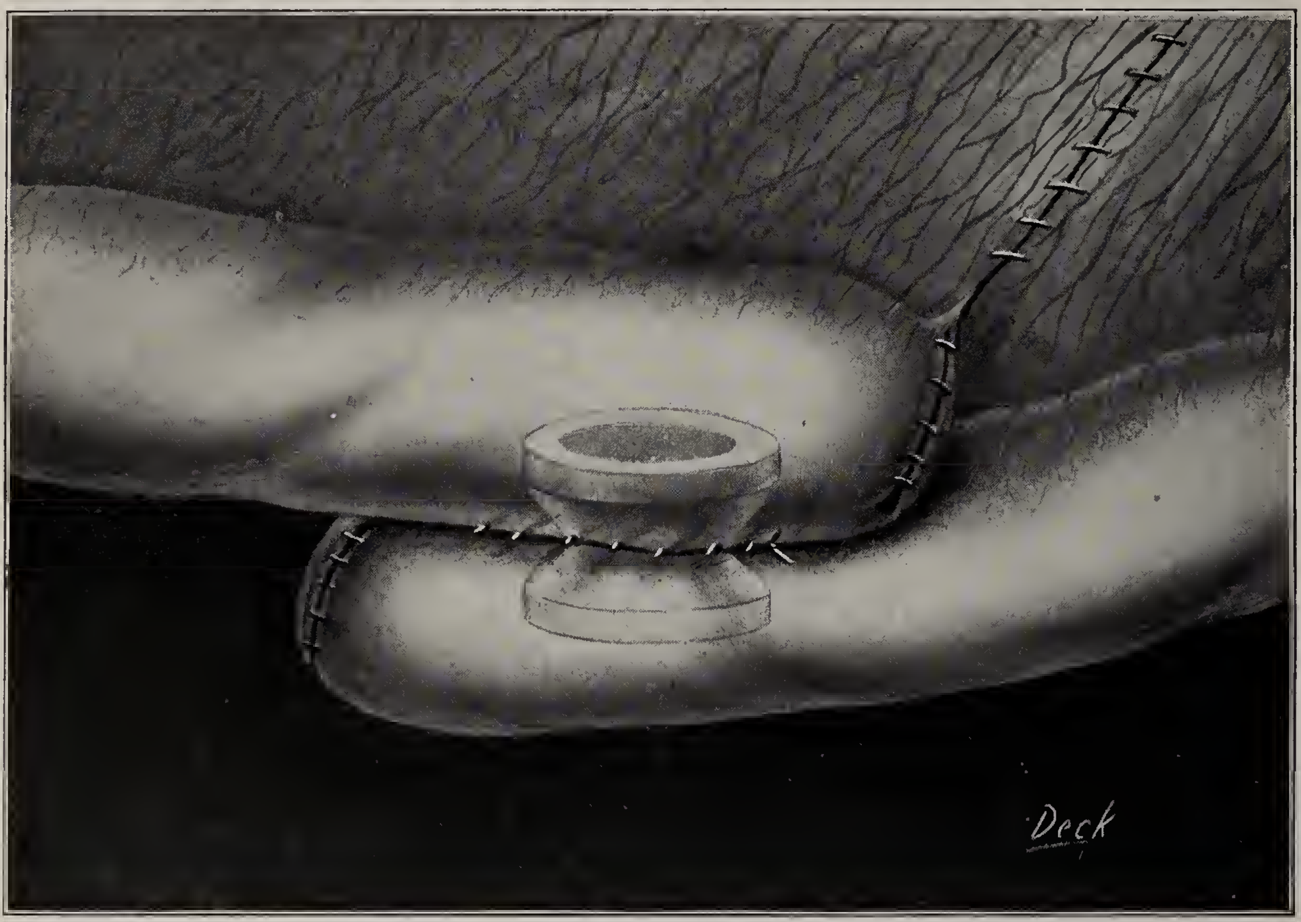

Fig. 441.—Lateral Enterorrhaphy with Vegetable Bobbin.
The last line of sutures completed and tied.

Treatment.—The treatment is operative in properly selected cases. In performing enterectomy for carcinoma of the bowel, if the site of the tumor can be identified, the incision is to be made directly upon it. The involved portion of bowel is to be drawn out of the wound and the remainder of the abdominal cavity well protected by gauze pads to prevent soiling. Madelung recommends that the unoccupied portion of the abdominal wound be temporarily sutured. Care should be taken to make the resection well into healthy tissues. The line of resection should be made somewhat obliquely from the mesenteric attachment to the convexity of the bowel. The after-treatment has been already dwelt on (see page 67).

The statistics of enterectomy for carcinoma show a remarkable improvement during the past two decades. A favorable prognosis may be given in early cases, while in advanced cases the operation should not be attempted, the establishment of an artificial anus, or colostomy, taking its place. In the rare instances in which the carcinoma is situated high up in the small intestine, colostomy is not available, death being threatened by inanition, and **elimination of the bowel,** the fecal current being "short-circuited," so to speak, by **intestinal anastomosis,** must be substituted (*vide infra*).

INTESTINAL OBSTRUCTION

Interruptions of the fecal current by stoppage or blocking of the intestinal canal may be classified in a general way as follows: (1) **strangulation,** or constriction of the bowel from without; (2) **angulation,** or obstruction from displacement, or simple flexure; (3) **rotation,** or obstruction from twist and complex flexure; (4) **compression,** or obstruction from blunt pressure from without; (5) **coarctation,** or obstruction from closure of the intestine from within; (6) **obturation,** or plugging of the intestine from within; (7) **coprostasis** from dynamic causes, such as **intestinal paresis** and **paralysis of peristalsis.**

The following clinical forms are distinguished:

1. **Internal Strangulation.**—In this form the constriction, and consequent occlusion, takes place from without, and is caused by (*a*) pressure from bands, the result of pre-existing peritonitis, and from adhesions from the same cause, the latter producing "kinking" or angulation; (*b*) the presence of a Meckel's diverticulum (the remnants of the omphalomesenteric duct); (*c*) the slipping of a loop of the intestine through a slit in the mesentery or omentum, or through a normal opening, such as the foramen of Winslow behind the hepatoduodenal ligament; (*d*) appendicular inflammatory lesions, in which the inflamed appendix vermiformis becomes adherent in such a manner as to surround more or less completely and constrict an adjoining loop of intestine (Fig. 458), or produce obstruction by pressure, as in the case of a band; (*e*) **internal hernia,** in which a loop of intestine enters the duodenojejunal fossa and is there imprisoned by the *musculus suspensorius duodeni* of Treitz acting as a band.

2. **Intussusception.**—In this form there is invagination or telescoping of one portion of the intestine into another, arising from irregular and forced peristalsis. Intussusception does not in itself produce complete obstruction. This arises from swelling of the parts involved due to the circulatory disturbances, and from accumulation of feces. The inflammation excited fixes the telescoped parts firmly in position; these may finally slough and come away. The invagination occurs from above downward and may be limited to five varieties: (1) the *colic,* in which the colon is prolapsed into itself; (2) the *ileocecal,* in which the ileum is prolapsed into the ileocecal aperture; (3) the *enteric,* in which the small intestine alone is involved; (4) the *colicorectal,* in which the colon descends into the rectum; (5) the *rectal,* in which

the rectum is telescoped into itself. There may be several coexisting points of intussusception (**multiple intussusception**). In a case occurring in my service at the Brooklyn Hospital five different points of intussusception were found in the small intestine of a three-year-old infant.

3. **Volvulus.**—This form is characterized by a twist of the bowel on its mesenteric axis. It occurs most frequently at the sigmoid flexure. The twist becomes more and more pronounced, with increasing distention of the bowel above the point of obstruction. The nutrition of the bowel is interfered with, early bacterial migration occurs, followed by septic peritonitis, the result of which is to fix the parts still more firmly in their abnormal position.

4. **Congenital and Other Occlusions and Acquired Strictures.**—These include (*a*) absence of a portion of the intestinal tube from arrest of development, such as imperforate anus, absence of the sigmoid and rectum or incomplete union between them, or between the duodenum and the pylorus, etc.;* (*b*) strictures from either malignant or benign morbid growths, the former of which are by far the more frequent; (*c*) cicatricial stenosis, the result of typhoid and other ulcerations; (*d*) occlusion by pressure from growths springing from the pelvis, from abdominal tumors, or from the presence of inflammatory exudates about the bowel.

5. **Fecal Obstruction.**—Impaction of fecal matter in an isolated portion of the intestinal tube, due to local arrest of peristalsis, results, if sufficiently prolonged, in paralysis of the involved portion of the bowel. With increase in the size of the mass and its desiccation and hardening, obstruction from plugging of the bowel results. Its most frequent seat is the large intestine in the neighborhood of the cecum. The nutrition of the wall of the bowel may be interfered with by the pressure of the hardened mass, which may be followed by bacterial infection of the surroundings. It is observed oftenest in females and follows most frequently habitual constipation and a sedentary life. It may be remotely due to congenital conditions. Hysteria and hypochondriasis are predisposing causes. It may depend on spinal cord affections.

6. **Foreign Bodies.**—Obstructions due to foreign bodies include those which arise from substances swallowed, such as coins, buttons, etc., and certain medicinal substances, *e. g.*, magnesia and bismuth. Obstructions from gallstones, enteroliths, and masses of lumbricoid worms are to be included in this

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* In a case of intestinal obstruction in an infant eighteen hours old, occurring in the practice of Dr. W. J. Cruikshank, and operated on by me at the Methodist Episcopal Hospital in Brooklyn, in 1896, a true omphalocele existed, through the diaphanous coverings of which a dark colored mass could be discerned, moving with the intestinal tube. Vomiting of meconium was present. The mass was not strangulated in the omphalocele. The latter was excised by an elliptic shaped incision. The mass was delivered through the abdominal wound and proved to be a dilated portion of small intestine, which appeared like an accessory cecum filled with meconium. The adjoining proximal tract of small intestine was likewise filled with meconium. The large intestine was empty. The pouch was resected. On examination the specimen proved to be a dilated portion of small intestine, with about half an inch of small intestine leading from each of its two openings. The opening which led in the direction of the large intestine was closed by a valvelike formation of mucous membrane, which effectually prevented egress of meconium from the sac. The malformation evidently originated at the site of the valvelike formation as an abnormality of the mucous membrane, and the pressure of the accumulating meconium in the small intestine forced the valve shut and led to the formation of the pouch. The latter lay just behind the umbilic opening, and by its increasing distention and pressure led to the development of the omphalocele. The child was well developed and healthy in every other respect and his recovery was uneventful and perfect.

class. Gallstones are most frequently arrested in the ileocecal region;* enteroliths are usually arrested elsewhere in the small intestine.

Symptoms and Course of Intestinal Obstruction.—The **onset** will depend on the cause of the obstruction. Symptoms of a chronic and progressive character may be present for a time, when symptoms of acute obstruction suddenly supervene.

Acute intestinal obstruction is characterized by a sudden onset, abdominal pain, nausea and vomiting, and inability to pass gas or feces after the part of the canal below the point of obstruction has been emptied. Tenesmus is sometimes present when the obstruction is low down in the large intestine. Distended coils of intestine sometimes elevate isolated portions of the abdominal wall, forming a tympanitic tumor. Cases involving interference with function of the bowel itself and causing nutritive and destructive changes in its walls, such as strangulation by bands, volvulus, etc., may be classified as **hyperacute intestinal obstruction.**

Chronic Intestinal Obstruction.—In cases of **impacted feces** diarrhea may be present at first, the mucous membrane near the impaction becoming irritated and furnishing a hypersecretion, which passes alongside the impacted mass, carrying some fecal matter with it. As the obstruction becomes pronounced, there is a sense of fullness and weight in the abdomen, anorexia, etc. There may be pain on pressure. When the obstruction is due to **malignant disease of the bowel wall,** constipation, and in some instances pain and localized tenderness, increased by the administration of cathartics, will form part of the previous history. There is increasing difficulty in moving the bowels, loss of weight and strength, and anemic cachexia.

In all cases of intestinal obstruction, whether acute from the outset or developing slowly, when the obstruction becomes complete, practically the same clinical picture is presented, though the individual features of this may vary somewhat, according to the **seat of the obstruction.** These are, in the main, pain, anxious countenance, hiccough, persistent vomiting, followed by fecal vomiting, tumultuous peristalsis in the beginning, distention, typic collapse, vasomotor paralysis from the effects of stercoremia on the nervous system as manifested by a bluish-red color of the surface, lowered temperature, and feeble pulse. In **malignant disease of the lower bowel** the stools are stained with blood. Tenesmus followed by bloody mucus passed *per rectum,* is specially characteristic of **intussusception.** Localized peritonitis giving rise to tenderness may be present in any form, but occurs with special rapidity in volvulus on account of the early interference with the nutrition of the bowel from the twist in the mesentery.

Diagnosis of Intestinal Obstruction.—The diagnostic acumen of the practitioner will not be so frequently taxed in determining the existence of obstruction as in deciding on its character and seat, though acute enteritis, acute poisoning, and strangulated hernia have all been mistaken for intestinal obstruction within the abdomen. The most frequent diagnostic errors, however, relate to appendicitis and peritonitis (see pages 96 and 37). A careful weighing of all the facts obtainable in the history of the case will be necessary first, after which the surgeon will endeavor to obtain additional light as to the location of the lesion. This, the so-called **anatomic diagnosis,** is always difficult, and frequently impossible without the aid of **exploratory abdominal section.** In all varieties and situations of intestinal obstruction the **seat of pain** is likely to be either at or near the umbilicus, or generally diffused. **Tenderness** is not always present, and its situation is rarely suggestive, much less diagnostic. From the greater frequency of **early fecal vomiting** in obstruction situated in the small intestine, this symptom may be of some service in the differentiation. A **tumor** felt by the finger in the rectum or vagina is suggestive of intussusception in an acute attack. A **stricture** felt in the rectum by digital exploration, or other evidences of disease in this locality, will be diagnostic. Exploration with the entire hand in the rectum is not justifiable.

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* In a case operated on by me for Dr. H. P. Bender, the obstruction was found to be due to a gallstone, which under ordinary circumstances could have easily passed through the intestinal canal. It was arrested, however, at the site of a stricture resulting from a carcinomatous infiltration of the bowel wall, which of itself had not encroached sufficiently upon the lumen of the gut to give rise to obstructive symptoms until it served to arrest the passage of the gallstone.

Obstruction high up in the small intestine is characterized by moderate distention at the upper portion of the abdomen, with flatness below and at the sides. In **duodenal** and **jejunal obstruction** the vomiting is not so markedly fecal. When the obstruction is in the ileum, the fecal vomiting is finally pronounced, the distention is at first central but becomes general as the distended coils of small intestine overlap the colon. There may be scantiness of urine in obstruction in the small intestine.

Obstruction in the Large Intestine.—If the lower portion of the colon is involved, there may be tenesmus, and bloody and mucous discharges, with perhaps indican in the urine. Differences between the extent of tympanitic distention in obstruction of the small intestine and its extent in obstruction of the large intestine are not sufficiently pronounced to be of service except very early in the case. Attempts to measure the capacity of the portion of large intestine below the seat of obstruction are sometimes made with indifferent success, but they are a waste of time.

Proportionate Occurrence.—Fully 35 per cent of all cases of obstruction are due to intussusception, and about one-half of the obstructions found in the large intestine are due to this condition; volvulus is next in frequency (30 per cent). Strangulation by bands, inflammatory adhesions, appendicular lesions, diverticula and true internal hernias constitute about 35 per cent of all the cases of intestinal obstruction. Of the remaining 30 per cent, one-half are due to volvulus, the majority of which, as has just been stated, occur in the large intestine, and are included in these figures. Of the 15 per cent still unaccounted for, 8 per cent are due to abnormal contents, of which gallstones are the most frequent, and 7 per cent to tumors, cicatricial contractions, and strictures from neoplasms in the bowel wall. Of the cases of obstruction occurring in the large intestine alone, 50 per cent are due to intussusception and 30 per cent to volvulus, the remaining 20 per cent being credited to tumor pressure and strictures from morbid growths in the bowel wall. Of the cases of obstruction occurring in the small intestine alone, 75 per cent are due to internal strangulation. Next in frequency comes obstruction by gallstones (14 per cent). Volvulus is not frequently met with in this locality, though cases are sometimes observed, and occlusion from tumor pressure is still more rare. These, and the presence of malignant disease in the small intestine, make up the remaining 11 per cent of cases of intestinal obstruction in that region.

Intussusception is much more likely to be present in children, and, with its abdominal tumor, bloody stools, and rectal tenesmus, is much more easily recognized than any of the other forms. Fully 75 per cent of the cases occur at or near the ileocecal junction. Intussusception rarely occurs after the age of thirty. **Cancer,** on the other hand, is essentially a disease of middle and advanced life. It is most frequently found at or below the sigmoid flexure. **Volvulus** rarely occurs before the age of forty, and affects males more than females; in at least 50 per cent of the cases the twist is at or near the sigmoid flexure. It is occasionally found involving the lower portion of the ileum. In rare cases nearly the entire small intestine is found to be twisted (Ashly). I have observed a similar case.

Nonmalignant strictures, as well as those due to malignant disease, are found most frequently at or below the sigmoid.

Analysis of Symptoms.—In obstruction in the duodenum and jejunum **vomiting** is an early symptom, but it is not fecal in character. In obstructions situated lower down in the small intestine it is also an early symptom, but it soon becomes fecal. It is longer delayed in the large intestine, is less severe, and may not become fecal until later, if at all. **Pain** is an early and prominent symptom in strangulation, as compared with the other forms of obstruction, except volvulus; when it is present in volvulus it is due to the early occurrence and rapid spread of the peritonitis. In strangulation and volvulus the involved portion of the bowel alone becomes the seat of **distention** at first, and this portion is free from peristaltic movement, owing to the mechanic fixation of its mesentery at the point of constriction. In **strangulation low down** the portion of the bowel above the strangulation fills up slowly, while in **strangulation high up** this becomes distended more rapidly. In **obstruction by plugging** the distention decreases in the direction of the stomach and the interference with peristalsis is less pronounced. **Peritonitis** forms a part of the previous history of internal strangulation in 68 per cent of all the cases, and in 12 per cent there have occurred previous symptoms of partial or complete obstruction. Peritonitis is present early in volvulus. In cases of obstruction from gallstones a previous history of inflammatory symptoms in the neighborhood of the gallbladder or duodenum may sometimes be obtained, as well as a history of biliary colic and jaundice, suggesting cholelithiasis. Gallstones sufficiently large to cause obstruction pass directly into the bowel by ulceration and perforation of the gallbladder. **Early vomiting and prostration** are significant of involvement of the small intestine in the obstruction; **tenesmus** and **bloody stools** are strikingly characteristic of that of the large intestine. A history of **subacute onset** and **chronic course** is obtained in fecal impaction, together with the presence of an **irregular tumor** in the course of the large intestine, where it occurs most frequently. A previous history of **constipation** and **obstipation** in a person in middle or advanced life, together with the presence of a **movable abdominal tumor,** the obstruction being often slow in its development, more rarely acute, will point to malignancy as the cause of the obstruction. **Loss of weight** and **strength,** and finally **anemia and cachexia,** are strongly corroborative. Further, the possibility of the occurrence of intestinal obstruction from more than one cause should be borne in mind (*vide supra*).

In general terms it may be stated that the existence of either internal strangulation or volvulus is rendered highly probable by **violent onset, severe and persistent pain,** and the occurrence of **early and profound collapse.**

Finally and above all, with the certainty that he has to deal with a case of intestinal obstruction, the surgeon should not waste valuable time in speculating as to its character and seat (attempts to determine these amount to this only too frequently), but should proceed at once to perform abdominal section, for the purpose of both confirming the diagnosis and saving the patient's life.

(For differential diagnosis from peritonitis and appendicitis, see pages 37 and 101.)

The Prognosis of Intestinal Obstruction.—All cases of hyperacute intestinal obstruction, *e. g.*, those arising from bands, angulation, rotation, volvulus, etc., invariably prove fatal without operation. The prognosis in operated cases will largely depend on (1) the promptness with which the abdomen is opened and the bowel released from its dangerous environment; (2) the damage inflicted on the intestine and mesentery; (3) the effects of the obstruction on the system at large.

The prognosis is more favorable in obstruction from causes residing within the gut, such as foreign bodies, gallstones, fecal impaction, etc., as well as occlusion from tumor pressure and masses of inflammatory exudates. The mortality in all forms is high, however, unless they are operated on early. If operative interference is not undertaken until the patient's strength is exhausted or general peritonitis has supervened, a fatal result is to be expected, and an undeserved opprobrium is cast upon the surgeon's work.

Abdominal Section for Intestinal Obstruction.—The incision is made in the median line (see page 29). The search for the point of obstruction must be methodic. It should commence below the umbilicus and the inguinal regions should be examined first. If the obstruction is situated in any part of the large intestine or in the lower portion of the small intestine, a distended loop above the obstruction presents itself in the wound (Senn). If the cecum is distended, the cause of the obstruction is below this; otherwise it is above. In all forms of intestinal obstruction the pale, empty, and contracted portion below the obstruction is always found in the pelvis, where it is forced by violent peristalsis after the expulsion of its contents. The distended portions being specifically high, and the pelvis being too small to hold the ballooned loops, the latter rise to the abdominal cavity. When collapsed intestine is found, the point of obstruction will be found where this commences and the distended portion terminates. The character of the obstruction is now determined and measures taken to relieve it. This may involve (1) simple section of a constricting band; (2) the removal of a gallstone, enterolith, or other offending substance from within; (3) resection of the intestine if its walls are damaged or are the seat of disease (see page 60); (4) intestinal anastomosis and elimination of portions of intestine which are the seat of inoperable obstructive lesions (*vide infra*); (5) under circumstances demanding prompt termination of the operation, the formation of an artificial anus for purposes of temporary relief. The parts to be operated on must be brought outside the abdominal cavity whenever possible and be well protected by large gauze compresses.

Excessive distention may embarrass the search and compel resort to **eventration,** with or without puncture of the intestine, the abdominal incision being enlarged if necessary (Kümmel). Attempts at replacement of greatly distended intestinal coils frequently result in injury to the latter. Besides, as

Senn has pointed out, overdistended paretic intestine in the abdominal cavity is always a source of danger from migration of pathogenic microorganisms. **Incision and evacuation** of the intestine are therefore advisable under these circumstances. The intestines must be kept warm while outside the abdominal cavity, and special care taken that they do not drag on the mesenteric attachments. Replacement is best effected by retracting and at the same time elevating the edges of the abdominal wound, and making firm, even pressure on the intestinal mass as loop after loop is guided into place. The replaced intestines are supported by an assistant's hand while the abdominal wound is being sutured.

Intestinal Anastomosis.—This is designed to effect union of portions of the intestinal tract more or less distant from each other without resection of an intervening portion. In cases in which the patient's condition demands haste, as well as when extensive disease exists and resection cannot be performed, it is a very useful expedient. It is employed most frequently in the small intestine, a loop of intestine as near as possible to and above the point of obstruction being selected and applied to the coil immediately below. The slits of communication should always be made on the surface of the bowel opposite the mesentery, and should be at least two inches in length to allow for subsequent contraction (see Lateral Enterorrhaphy, page 71).

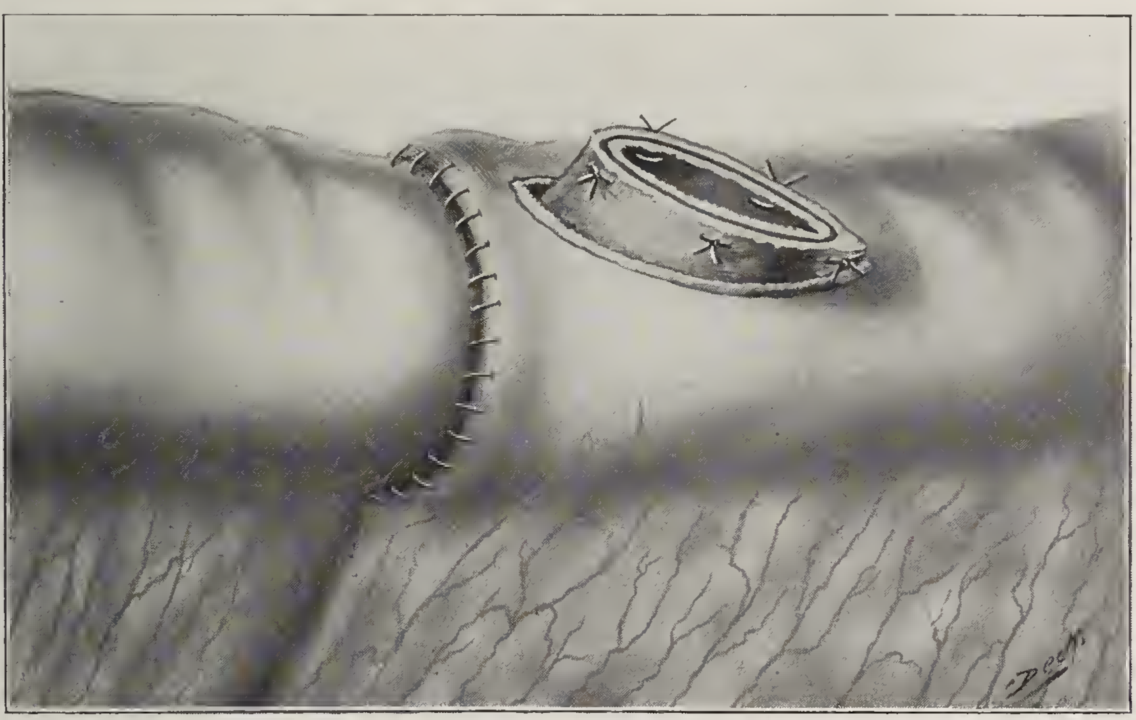

FIG. 442.—BARKER'S OPERATION FOR INTUSSUSCEPTION OF INTESTINE.

The neck of the invagination is seamed by a running suture including the serosa and muscularis. The sheath or intussuscipiens is opened, the invaginated portion excised as far as possible, and its stump sutured.

In cases of **intussusception,** when a tumor can be made out, the incision may reach this directly. When the invagination is reached, it is to be reduced by first massaging the venous congestion at its lowest part and then effecting reposition by gentle traction from above and pressure from below. This failing, adhesions may be broken up by passing a probe between the opposed serous surfaces. When the intussusception cannot be reduced, the intussusceptum is excised (Barker's operation) as follows: The two portions of bowel are united by means of a continuous suture of silk at the neck of the invagination, or the point where the sheath receives the entering layer of intestine (Fig. 442). Should the bowel at this point threaten gangrene, more bowel should be invaginated until healthy bowel is reached. The suture should include both the serous and the muscular layer of the bowel. The bowel constituting the sheath or intussuscipiens is opened by a longitudinal incision and the intussusceptum or invaginated portion exposed. The latter is then drawn through the incision and is excised as completely as possible. The stump left after the excision represents the cut edges of the two layers of bowel. These layers are now sutured firmly together with interrupted sutures of silk. The suturing is commenced as soon as a sufficiently large opening through which to work is obtained. The last suture must include the stump of the mesentery before the section is finally completed. The stump is now dropped back through the incision into the lumen of the intussuscipiens and the longitudinal incision is closed.

If the intussusceptum cannot be drawn out through the longitudinal incision in the bowel, it must be divided *in situ* and sutured as before. This, however, adds some difficulties to the operation.

In closing the abdomen, if there is any suspicion as to the state of the bowel, a gauze strip should be laid at the site of the operation and led out of the abdominal wound.

(For after-treatment of abdominal section, see page 31.)

In cases of **intestinal paralysis** in which death threatens from overdistention and septic absorption the abdomen should be opened, the bowel incised in a number of places and sutured after evacuation, and an artificial anus formed in the area of greatest distention. The latter may close spontaneously if the patient recovers, or it may be cured operatively.

CARCINOMA OF THE STOMACH

In liability to cancer the stomach ranks next to the mammary gland and the uterus. The disease originates in the glandular apparatus of the gastric mucous membrane and is most commonly situated at or near the pylorus. The cardiac orifice is attacked in about 10 per cent of the cases (Brinton). The disease attacks the fundus in less than 1.5 per cent of the cases (Welch). The edges of gastric ulcers, and cicatrices which mark the site of old ulcers, are believed to be favorite points for their development.

The disease invades the muscular coat and often extends to the serous coat as well. The further course of the local disease includes pyloric obstruction when the disease is situated at this orifice, infiltration, ulceration and sloughing of the mucous membrane, and bleeding. Involvement of the serous surface leads to the formation of adhesions to the surrounding structures. In this manner a mass is formed, consisting of the omentum and transverse colon, with adhesions to the liver and sometimes to the parietal peritoneum. The omental tissues in the mass, as well as the gastric carcinoma itself, sometimes undergo colloid or myxomatous degeneration. The disease extends along the lesser curvature from the cardiac and pyloric extremities; exceptionally it may extend along the duodenum from the pylorus. The disease finally invades the liver and gall-bladder, the pancreas, colon, spleen, and diaphragm through the medium of the peritoneal adhesions. Owing to the comparative scarcity of lymphatics at the fundus (Fig. 443) the latter is rarely involved in the extension.

Lymphatic glandular infection occurs in the gastrohepatic omentum, in the lumbar glands, and in those in the posterior mediastinum. Dissemination occurs, secondary nodules forming in the liver and lungs and sometimes in the ovaries.

The disease is most common between the thirtieth and the sixtieth year of life. Exceptionally it may occur earlier. Owing to the importance of the organ attacked, it usually proves fatal within a year, particularly when the cardiac or the pyloric orifice is affected first. Death usually takes place from starvation, sepsis, and hemorrhage. Fatal peritonitis ensues when perforation takes place into the peritoneal cavity, and fatal pleurisy from perforation of the diaphragm.

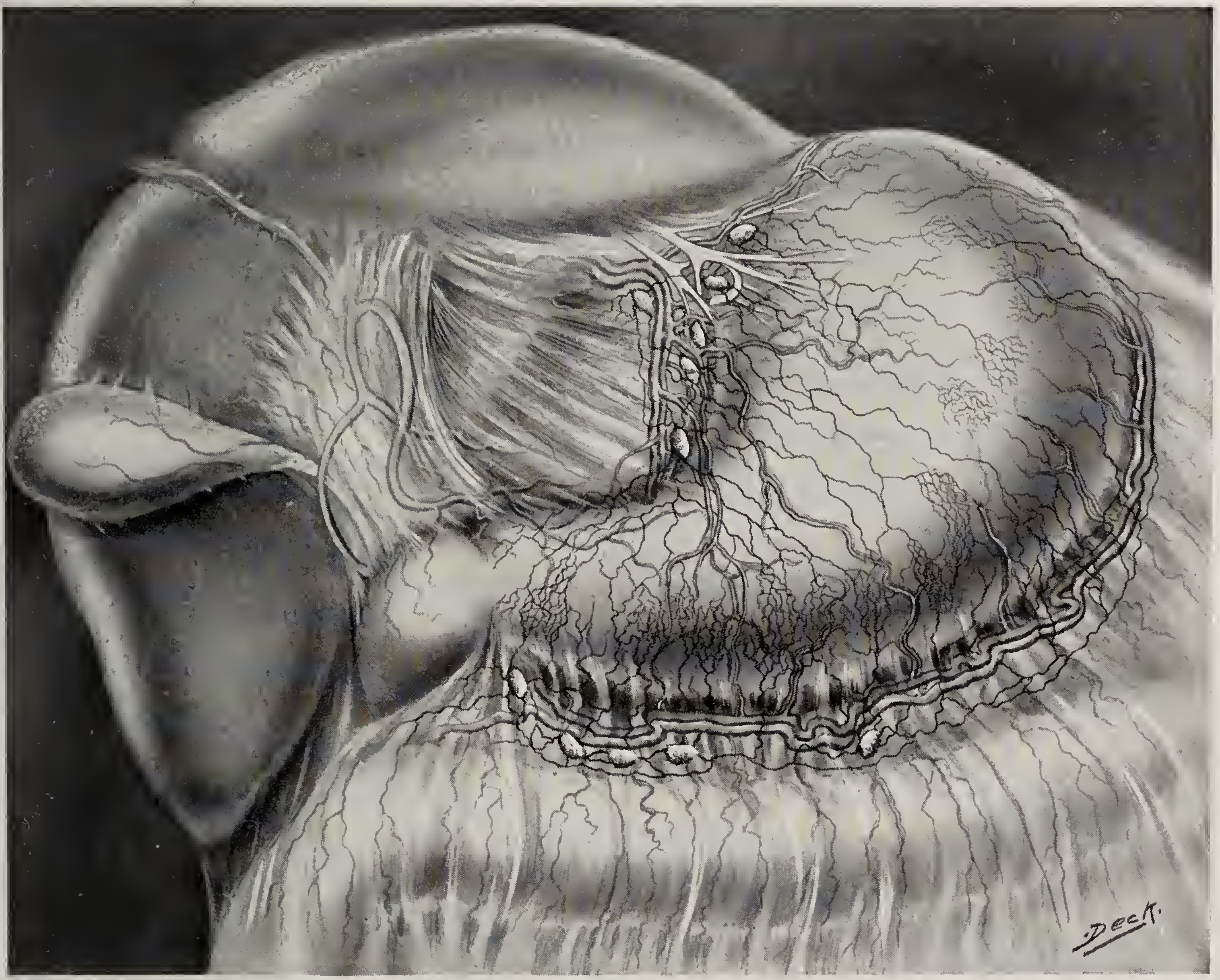

Fig. 443.—The Lymphatics of the Stomach.

The symptoms and diagnosis of cancer of the stomach are usually relegated to the domain of internal medicine. It is well, however, for the surgeon to bear in mind the following points: (1) the ordinary methods of diagnosis of the physician, particularly laboratory methods, are usually untrustworthy in the stage of the disease when surgical art can be of the greatest help to the patient; (2) **exploratory incision** is a trustworthy, practically dangerless, and almost indispensable diagnostic resource; (3) to wait for the development of a palpable tumor is to condemn to death the large majority of these cases; (4) cancer of the stomach cannot be excluded because of the absence of symptoms of pyloric obstruction, since advanced disease of the body of the organ may be present; (5) a history of previous gastric ulcer, instead of allaying, should rather arouse suspicion of cancer. It is now believed that ulcer of the stomach is an important factor in the causation of cancer.

The most important **indication for radical operation** in cancer of the stomach is movability of the involved parts. A growth that is small but fixes the stomach to its surroundings offers far less chance for its successful removal than one much larger but freely movable. The presence of adhesions limiting the movements of the stomach increases the difficulties of the operation, as well as the immediate mortality, and is likewise evidence of extension of the disease into the surrounding structures. Limitation to the pyloric end of the stomach offers a more favorable outlook than when the disease occupies a more extended area. Finally, **exploratory incision** will determine the matter in doubtful cases. If extensive and undoubted lymphatic infection can be excluded by this means, a radical operation may be proceeded with. (See Gastrectomy, page 86.) Otherwise, and if pyloric obstruction constitutes the indication to be met, only a palliative operation will be undertaken (see Gastroenterostomy, page 90).

OPERATIONS ON THE STOMACH

In the preparation of the patient the stomach should be washed out the day before, and just before the operation as well, if the patient's condition will permit. Fluid nourishment in small quantities should be given up to the morning of the operation. To obviate shock subcutaneous injections of saline solution administered (30 ounces every twelve hours) for two days before the operation are recommended (Allen, Mayo). The preliminary hypodermic injection of morphin will minimize the amount of anesthetic required.

The first incision should always be exploratory. It is placed in the median line, half-way between the ensiform cartilage and the umbilicus, and should be only large enough to admit two fingers. If the case is further operable, the incision is enlarged in both directions; the umbilicus is to be excised if the incision involves this structure. The further steps will vary according to the procedure decided on. The general technic includes (1) careful hemostasis; (2) protection of the abdominal cavity from infection by stomach and intestinal contents; (3) accurate closure of the openings in stomach and intestine.

Gastrotomy.—Foreign bodies in the stomach constitute the most frequent indication for incision into that organ. The site of the incision may depend on the location of the foreign body if this is fixed; in the case of a metallic foreign body the location may be determined by the Röntgen rays. In the absence of any guide to its exact location, the incision may be made parallel to the left costal arch and through the rectus muscle (Fenger), or in the median line. In recent cases the extraction of the foreign body is followed by suture of the wall. In old cases adhesions may be present, or even an abscess may have formed, in which case a gastric fistula may follow.

Exploratory Gastrotomy.—In view of the difficulties of recognition of carcinoma of the stomach in the beginning of the disease, and the importance of an early diagnosis from the surgical standpoint, an exploratory incision exposing the interior of the stomach to inspection is justified in proper cases (*vide supra*). If the procedure is limited to the exploratory incision, the abdominal wound should be closed with buried silver wire or silk sutures, these including only the aponeurotic structures of the linea alba, in order to allow the patient to get about at once (W. J. Mayo).

Gastrostomy, or the formation of an artificial gastric opening, is designed to permit direct access to the stomach for feeding purposes in case of impermeability of the esophagus, and thus prevent death from starvation. Cicatricial strictures, new growths, deep diverticula, foreign bodies, and congenital absence of the esophagus are the usual indications.

Witzel's Operation.—The anterior wall of the stomach is brought out of the abdominal incision, which may be made through the left rectus muscle, and a small opening is made into the cavity of the stomach, through which a rubber tube is passed. The tube is then depressed into a furrow on the stomach wall and the adjacent edges of this furrow folded over the tube and stitched together (Figs. 444, 445). The free end of the tube is led out of the abdominal wound and the stomach is stitched to the peritoneal surface of the abdominal wall. The external wound is then closed. Unless the condition of the patient is such as to demand immediate nourishment, it is better to keep the stomach at rest for a few days and feed by nutrient enemas (Maylard). Witzel claims that a valvelike occlusion forms at the inner opening and prevents escape through the tube. This seems to have been confirmed by the post-mortem findings in a case of Meyer's. The tube is to be worn constantly, though Witzel in one of his earlier cases reinserted the tube at each feeding. In nonmalignant stricture of the esophagus the opening may be allowed to close when the stricture is well dilated.

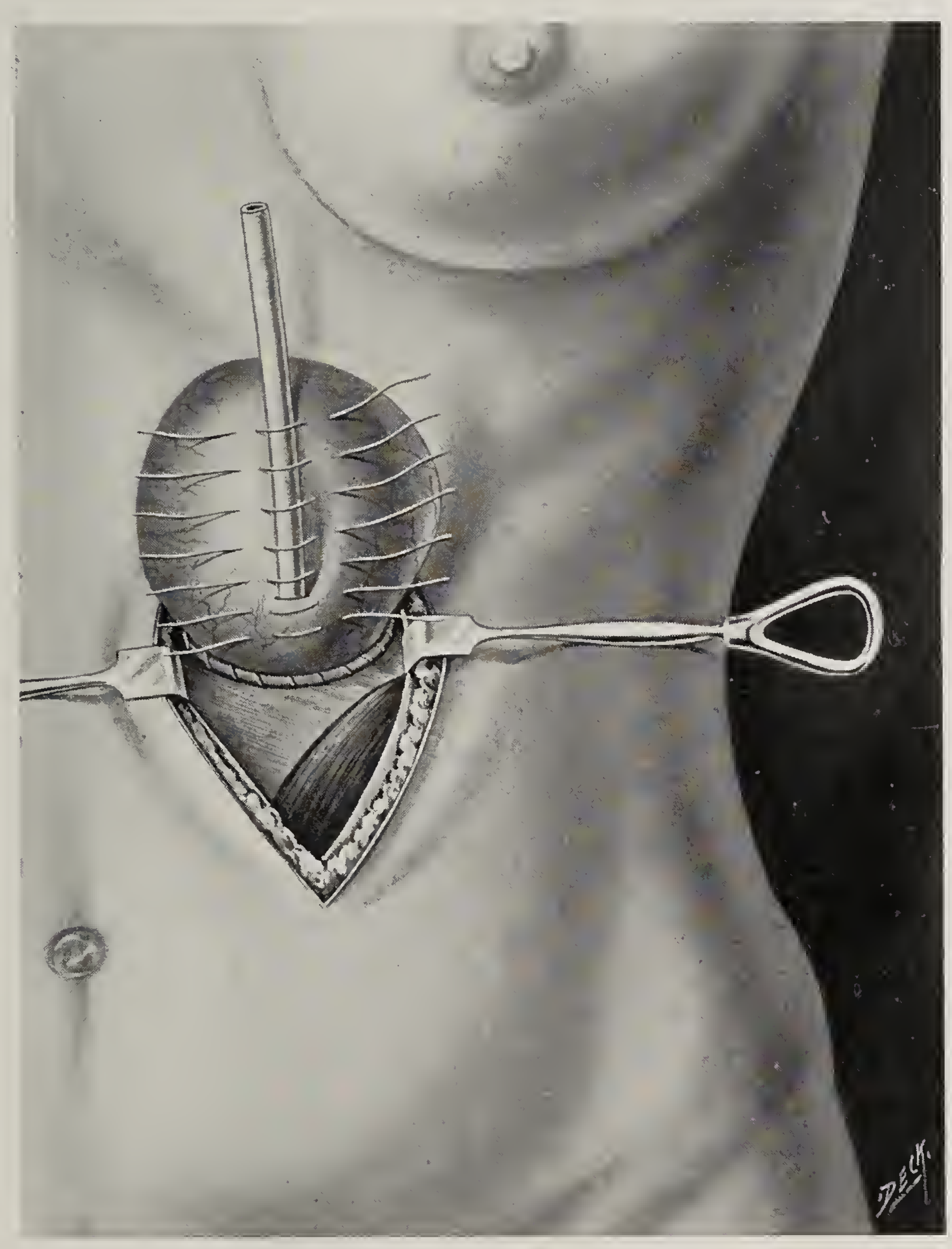

Fig. 444.—Witzel's Method of Gastrostomy. The Tube in Position.

The formation of a **subcutaneous esophagus** from the wall of the stomach was first devised and carried out, according to Maylard, by Sabanajew in 1890. Franck performed it in 1892, in Albert's clinic. The technic is as follows: An almost vertical incision is made over the left rectus muscle, which is commenced about two fingerbreadths below the margin of the ribs. The parts are divided down to the muscular fibers, and these are bluntly separated in a vertical direction toward the inner edge of the wound and drawn outward by a retractor. The posterior layer of the rectus sheath is now divided and the peritoneum opened. The stomach is now identified and a portion of the same drawn out of the wound. This, which consists of a long conical diverticulum of the organ, is sutured by a continuous suture around its base to the parietal peritoneum and the posterior sheath of the rectus (Fig. 446). A small incision is now made through the skin at the level of the costal cartilages, through which slender forceps are passed, and the apex of the cone is grasped and drawn up between the skin and the costal cartilages and out of the upper wound, to the edges of which it is fixed by two sutures. The lower wound is now closed. The portion of the stomach projecting through the upper wound is opened and the edges of the opening still further secured to the skin wound by sutures (Fig. 447).

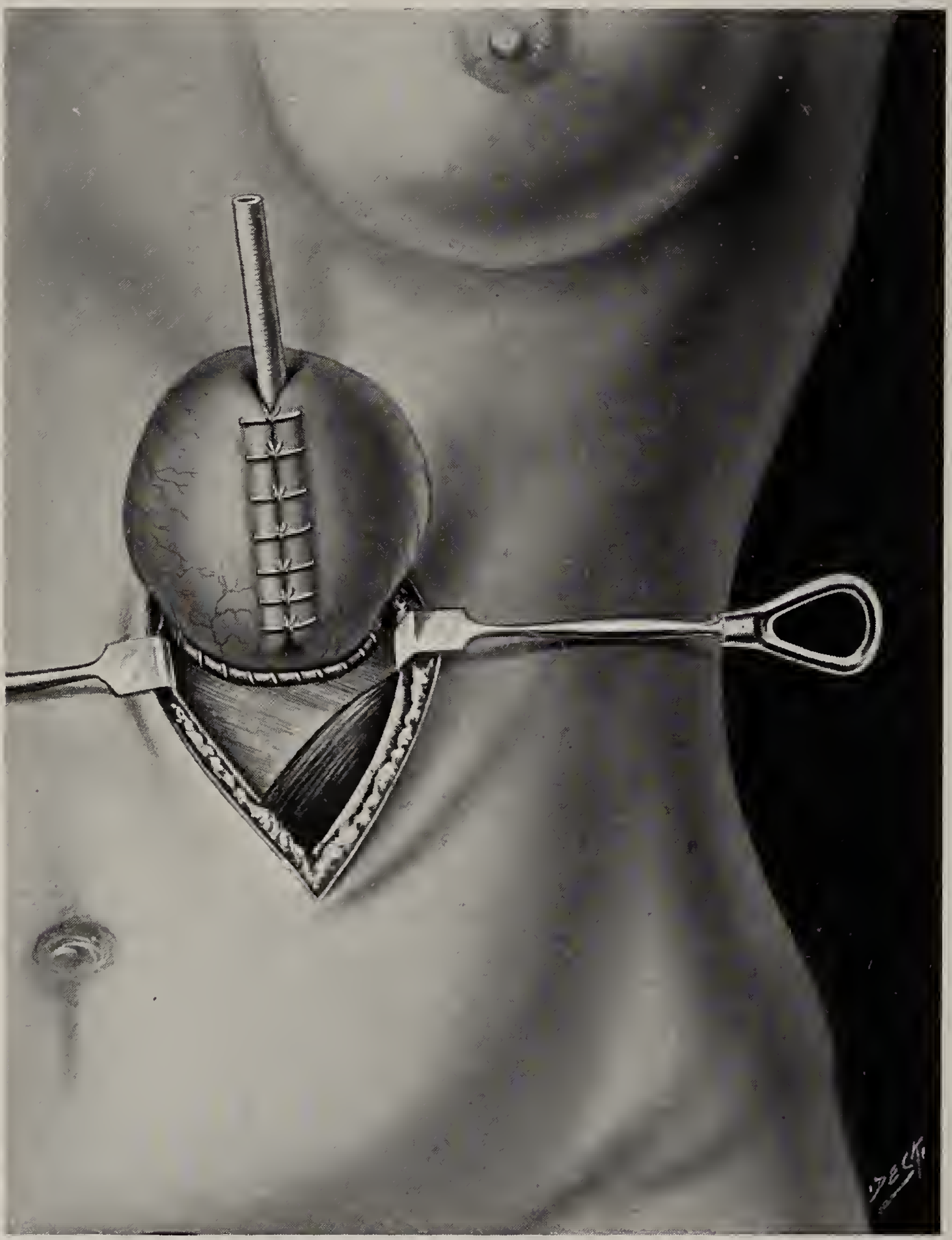

Fig. 445.—Witzel's Method of Gastrostomy. The Tube Secured.

The patient feeds himself through a catheter passed along the short subcutaneous esophagus thus formed. Escape of the contents of the stomach is prevented by the grasp of the base of the diverticulum by the muscular fibers of the rectus.

The Method of Formation of an Artificial Esophagus by Inverting the Stomach Wall (Kader).—This is the method of choice in cases in which a sufficient area of stomach wall is available for purposes of inversion. It consists of the formation of an artificial esophagus made by inverting a cone formed from the stomach wall. The organ is exposed and drawn into the wound. A small opening is made in the stomach, into which a rather thick-walled tube of rubber is passed for about half an inch into the stomach and there secured by two chromicized catgut sutures. Three circular rows of silk sutures (pursestring sutures) are now applied a quarter of an inch or more apart (Fig. 448). Inversion of the cone is effected in successive steps, which is commenced at the apex of the cone, where the tube is sutured, by pressure on the latter, each portion included in a pursestring suture being secured by drawing upon the latter and tying it as it closes around the tube. In this manner an inch or more of the stomach wall can be inverted. When all three of the rows of sutures are tied, two or three chromicized catgut sutures are passed through the serosa and

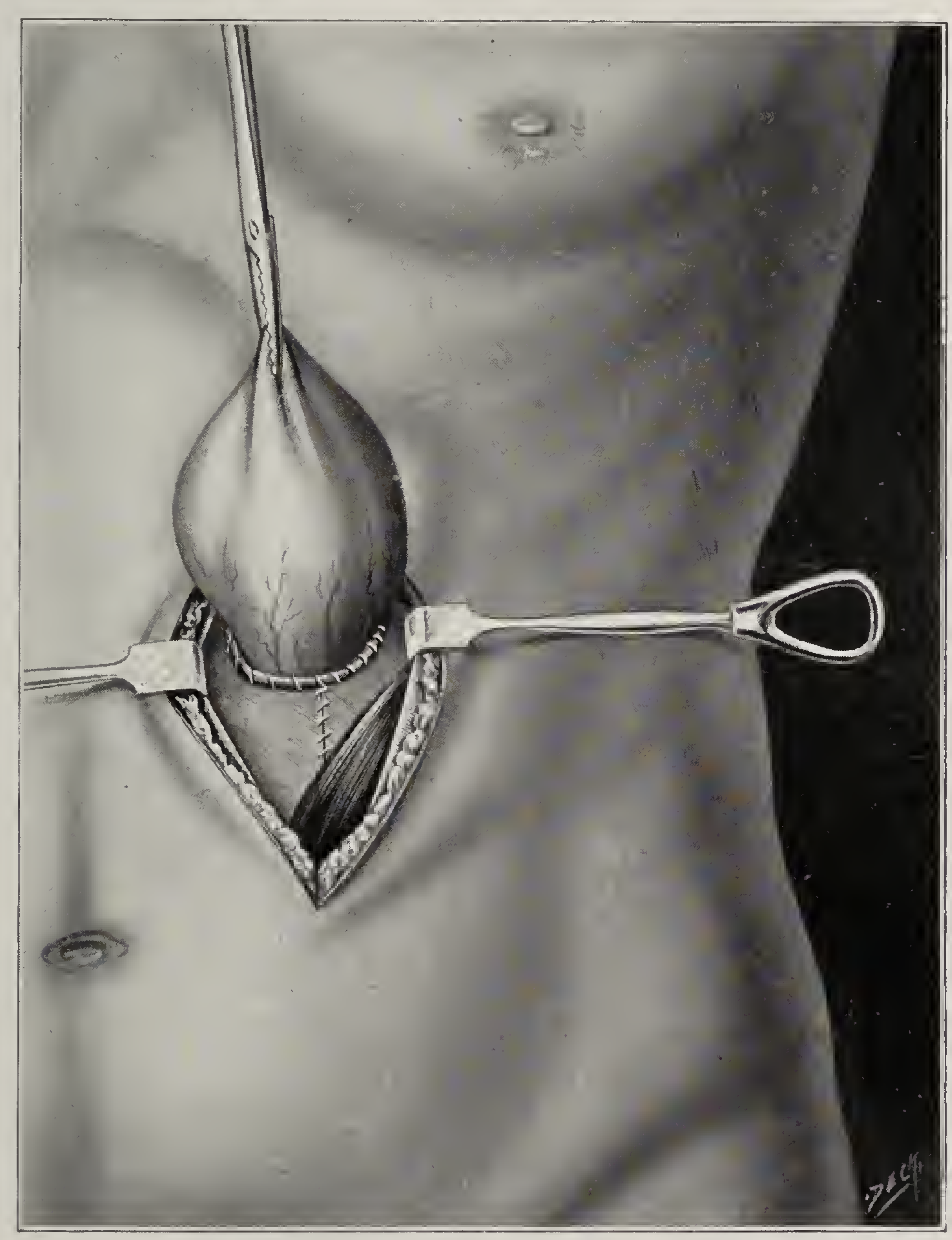

FIG. 446.—FRANCK-ALBERT METHOD OF GASTROSTOMY.

the muscular wall of the stomach, to hold the inversion securely until healing takes place. In closing the abdominal wound the deep sutures should include the serosa and muscularis of the stomach wall, to prevent undue tension on the portion grasping the tube.

The catgut sutures which hold the tube within the cavity of the stomach soften in a few hours, when the tube is to be withdrawn slightly so that the edges of the opening fall together. At each time of feeding during the next two weeks the tube is pushed forward for this purpose, but in the intervals it is kept withdrawn, though not removed altogether. Finally, when cicatrization is complete, the tube may be withdrawn altogether in the intervals.

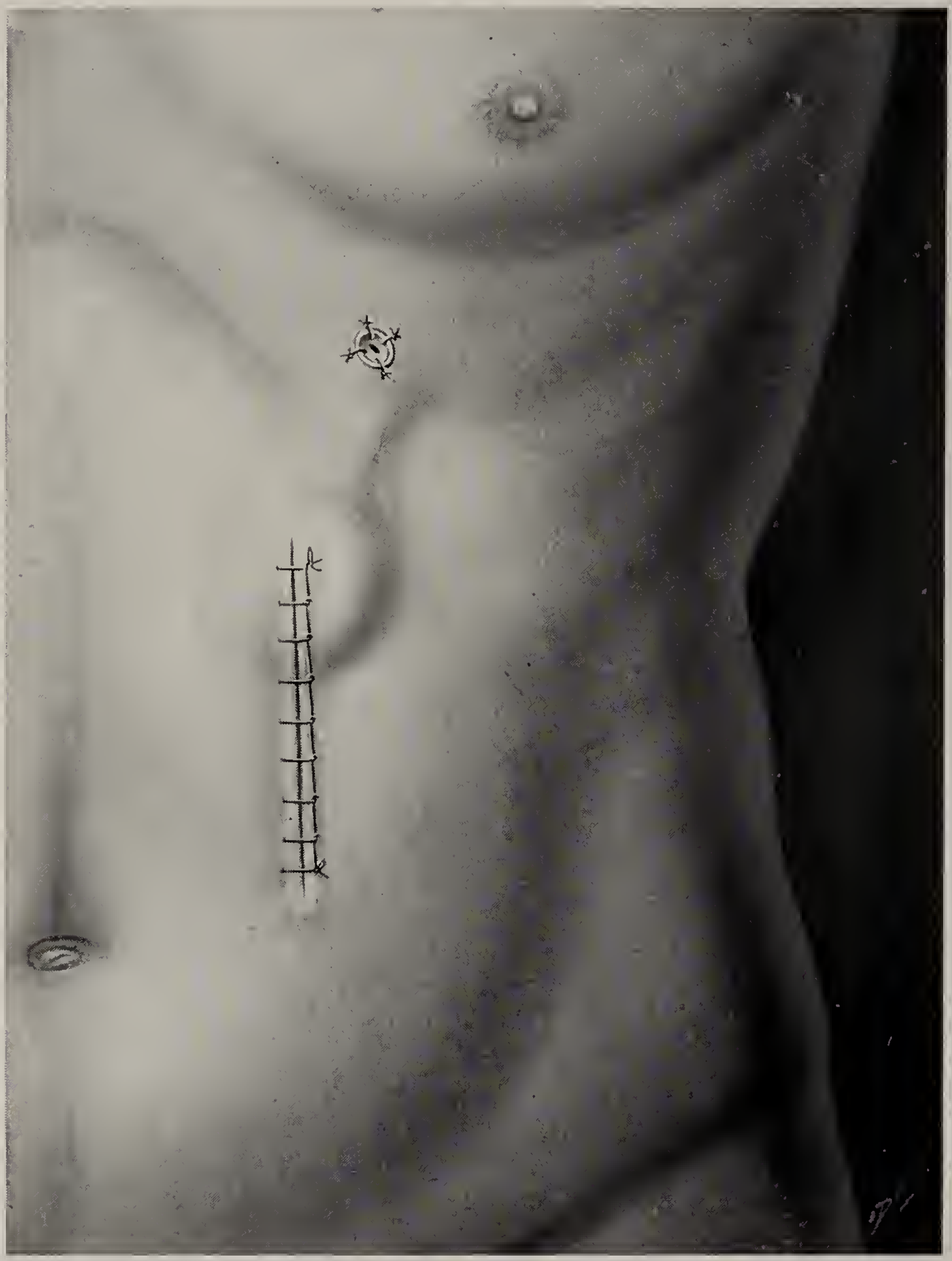

Fig. 447.—The Franck-Albert Method of Gastrostomy. The Wound Closed.

Gastrectomy.—This consists of removal of all or a portion of the body of the stomach. The operation may be indicated by carcinoma, hemorrhage into the stomach from gastric ulcer, and by perforating gastric ulcer. When performed for gastric ulcer and its sequels, the technic includes excision of the ulcerated base, ligation of the bleeding vessels, and repair by the Lembert suture (Rydygier). The incision is made in the median line and the part to be excised drawn well out in the wound. If **complete gastrectomy** is contemplated, ability to approximate the cardiac and duodenal regions must be assured. In partial gastrectomy, for convenience in securing the organ against slipping away, two sling sutures (Maylard) are to be passed through the part to be retained. To effect partial removal it will be necessary to detach the lesser omentum corresponding to the portion removed. In complete gastrectomy all the attachments of the stomach are to be divided, including the gastrophrenic ligament. In division of the lesser omentum and the gastrocolic omentum, this must be effected between two lines of ligatures. In **removal of the pyloric end** the line of section should follow the Mikulicz-Hartmann line (Fig. 449). The **technic of Mayo** is the best. This includes the following:

1. Preliminary double ligation of (*a*) the gastric vessels about an inch below the cardiac end of the stomach, (*b*) the pyloric branch of the hepatic (superior pyloric) and the gastroduodenal, or its right gastro-epiploic branch, either just above or behind the pylorus, (*c*) the left gastro-epiploic artery distad to the Mikulicz-Hartmann line.

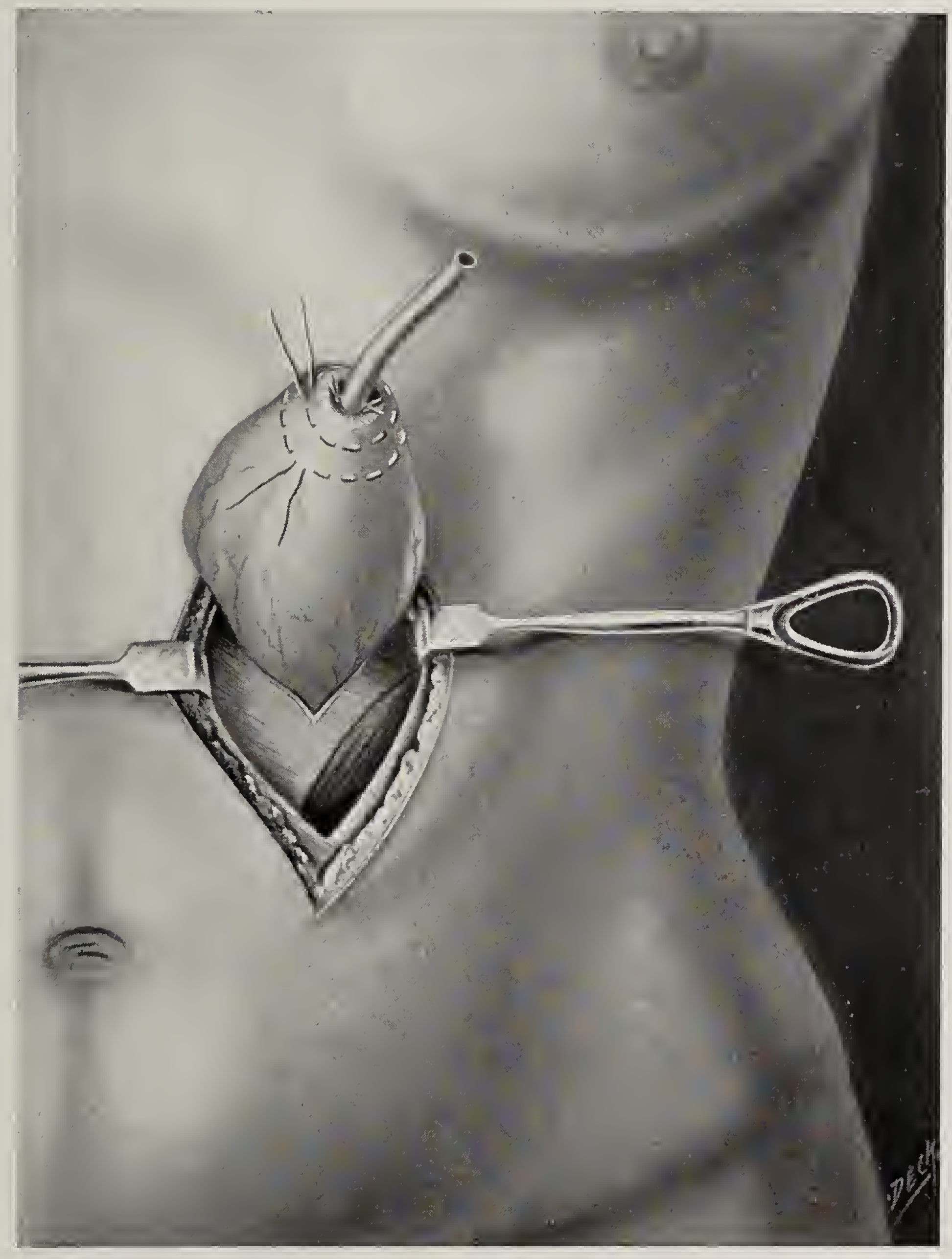

Fig. 448.—Kader's Method of Gastrostomy.

2. Double ligation and section of (*a*) the gastrohepatic omentum, (*b*) the gastrocolic omentum (Fig. 449). Care should be taken to avoid the middle colic branch of the superior mesenteric artery, usually the sole supply to the transverse colon.

3. Double clamping, with a three-quarter inch interspace, of the duodenum, followed by (*a*) section with the thermocautery, (*b*) provisional closure of the

duodenal end with a running suture of catgut, (*c*) removal of the clamp and inversion and permanent closure with a pursestring suture (Figs. 450 and 451).

4. The application of two long curved Hartmann's clamps covered with rubber tubing, one to each side of the Mikulicz-Hartmann line, with at least three-quarters of an inch of tissue between them (Fig. 450), followed by (*a*) section between the clamps with the thermocautery and the application of forceps to the edge to prevent retraction, (*b*) final removal of the pyloric end of the stomach and tumor, (*c*) temporary over-and-over suture of the cauterized end of the stomach with catgut (Fig. 451), (*d*) removal of the Hartmann's clamp and ligation of bleeding points, (*e*) permanent closure of the opening in the stomach with an infolding (Fig. 426), or a Lembert silk suture (Fig. 452).

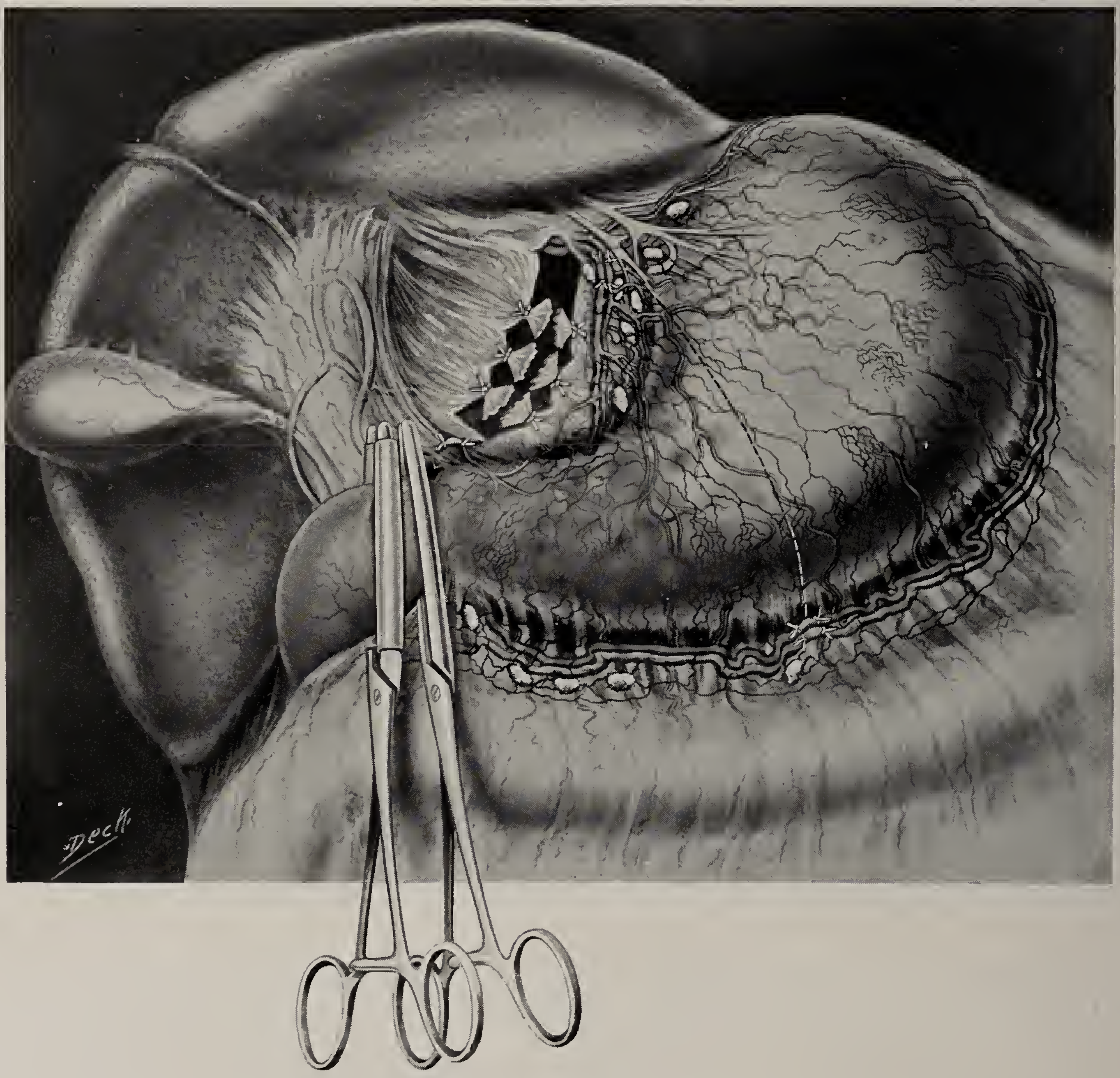

Fig. 449.—Partial Gastrectomy.

Showing the gastrohepatic omentum ligated and divided at three points, the gastric vessels ligated, and clamps applied at the point of proposed division at the pylorus. The dotted line (the Mikulicz-Hartmann line) shows the place of division of the stomach.

5. Independent gastrojejunostomy, preferably by the posterior method if the patient's condition will permit it; otherwise anteriorly with the Murphy button (Fig. 452).

If on opening the abdomen the carcinomatous mass is found to be attached to the pancreas and not elsewhere, a portion of the latter may be removed with the pylorus. If, however, the infiltration extends to the lesser omentum, a complete operation cannot be performed for the reason that the thickened edge of the latter (the hepatoduodenal ligament) contains the common bile-duct, the portal vein, and the hepatic artery. Attachments to the mesocolon likewise contraindicate removal on account of the subsequent dangers from **gangrene of the transverse colon.** Under these circumstances resection must be abandoned for **posterior gastrojejunostomy** (see page 90). In complete removal of the stomach (**total gastrectomy**) the stump of the esophagus is to be united to that of the duodenum by a procedure similar to that employed in end-to-end enterorrhaphy (see page 62).

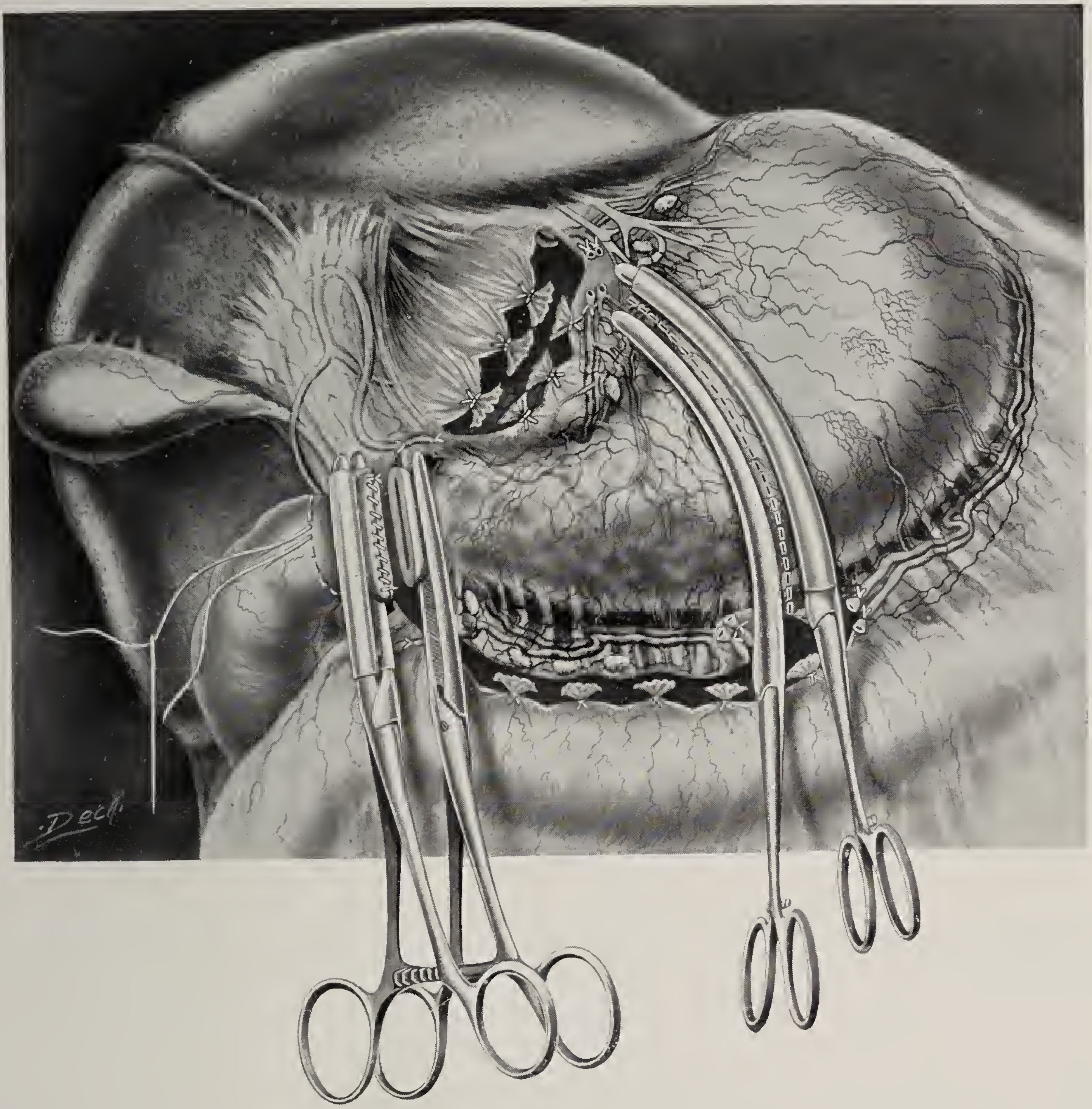

Fig. 450.—Partial Gastrectomy.

Showing the gastric vessels divided between two ligatures, the duodenum divided between two clamps and its distal end closed temporarily with a running suture of catgut, and a pursestring suture applied for permanent inversion of the duodenal end. A curved Hartmann clamp is applied on each side of the dotted line showing the site of the section of the stomach. The portion of the stomach removed includes practically all of the lymphatic glands of the organ. Note that the clamps applied to the portion of the stomach to be removed are uncovered; the others are covered with rubber tubing.

In the after-treatment of gastrectomy nutrient enemas are to be given for the first week, but teaspoonful portions of milk, gradually increased, may be given experimentally after the first thirty-six hours.

Pyloroplasty.—This operation is designed to increase the size of the pyloric outlet in certain cases of nonmalignant cicatricial stricture of the pylorus. The operation consists of first opening the stomach itself near the pylorus and passing a grooved director through the stricture as a guide, on which a longitudinal incision is made from the stomach to the duodenum, laying open the stricture and the parts on each side. The middle of the wound on each side is retracted until the opening is diamond-shaped and the opening is sutured at right angles to the original direction of the incision (Fig. 453).

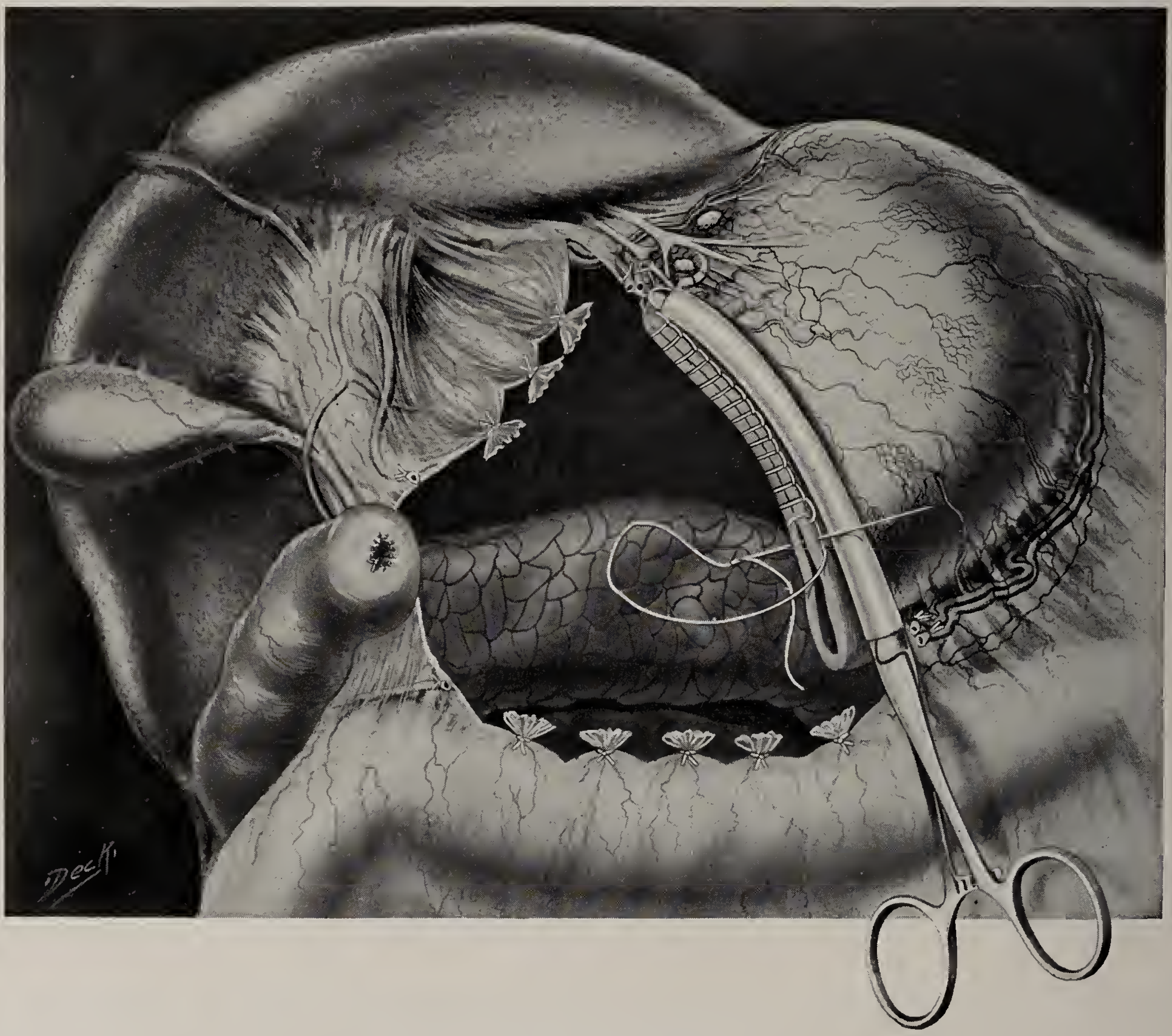

Fig. 451.—Partial Gastrectomy.
Showing the duodenal end inverted and secured by a pursestring suture, and provisional closure of the opening in the stomach by a continuous catgut suture.

Gastroenterostomy or, more properly, **gastrojejunostomy** is the formation of an anastomosis between the stomach and the small intestine, most frequently the jejunum. It is indicated (1) as a palliative measure in inoperable carcinoma of the pylorus; (2) as a radical measure in nonmalignant stenosis of the pylorus; (3) in cases in which neoplasms in the neighborhood, or involving the stomach, produce extreme dragging upon the latter; (4) in cases of high grades of dilatation of the stomach; (5) after resection of the pyloric end of the stomach; (6) in cases of hematemesis.

The stomach is washed out and chloroform administered when not otherwise contraindicated. A median incision is employed. The stomach is identified and the existing conditions indicating the operation confirmed. The greater omentum and transverse colon are turned upward and to the left to expose the small intestine. A loop of the latter is isolated and a search made for the jejunum. This is facilitated by observing, as the intestine is passed rapidly over, the color and thickness of the latter. As the duodenum is approached the jejunum becomes thicker and paler; in the direction of the ileum the color deepens and the gut is thinner. Having determined the upward direction, the surgeon continues the search until the plica duodenojejunalis (Zuckerkandl) comes into view. The anastomosis is to be made as near the latter as possible. A slit is made in the transverse mesocolon, at a point where it is in relation to the posterior wall of the stomach, the margins of which are sutured to the stomach wall so as to expose an area of the latter $2\frac{1}{2}$ inches or more in diameter (Hacker, Fig. 454). Or, the suturing may be dispensed with if a good sized area of the stomach wall can be brought through the slit in the mesocolon and grasped with slender forceps covered with rubber. The loop of jejunum is brought up into position in order to make sure that this can be done without tension and placed so that the direction of its peristalsis is coincident with that of the stomach. The portion of intestine selected is emptied of its contents by "milking." Or, an occlusion ligature of

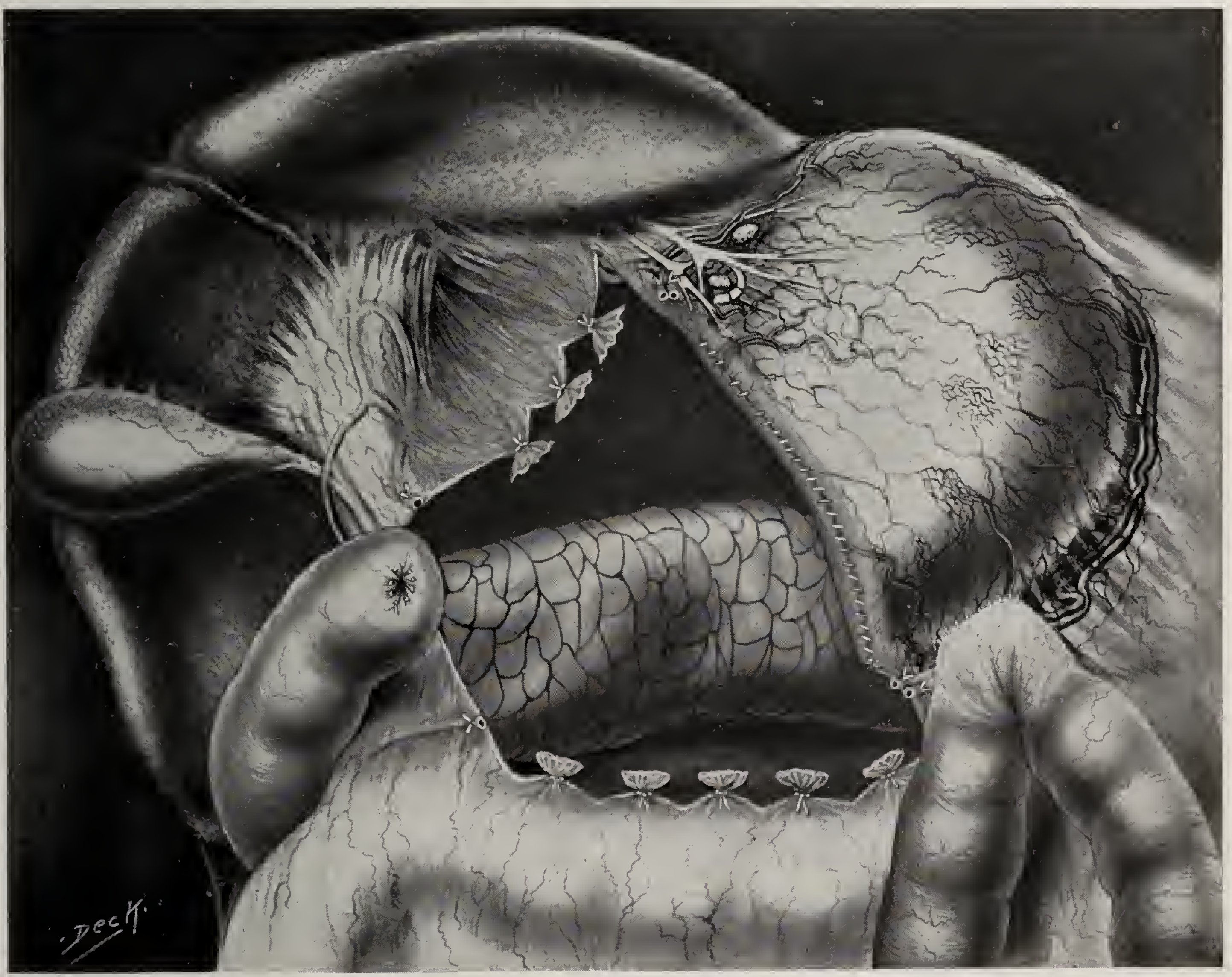

Fig. 452.—Partial Gastrectomy.
The opening in the stomach is completely closed and the gastro-intestinal canal restored by independent gastrojejunostomy.

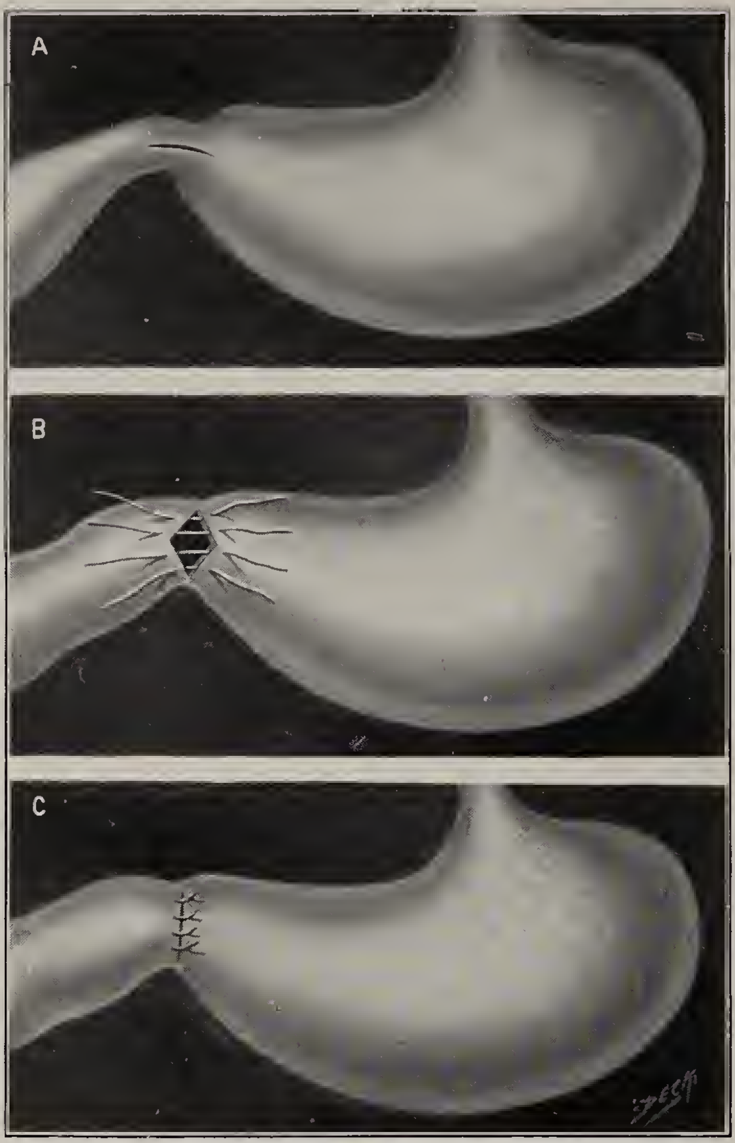

Fig. 453.—Pyloroplasty.
A, Horizontal incision at the site of stenosis; B, the incision opened vertically and the suture applied; C, the incision sutured.

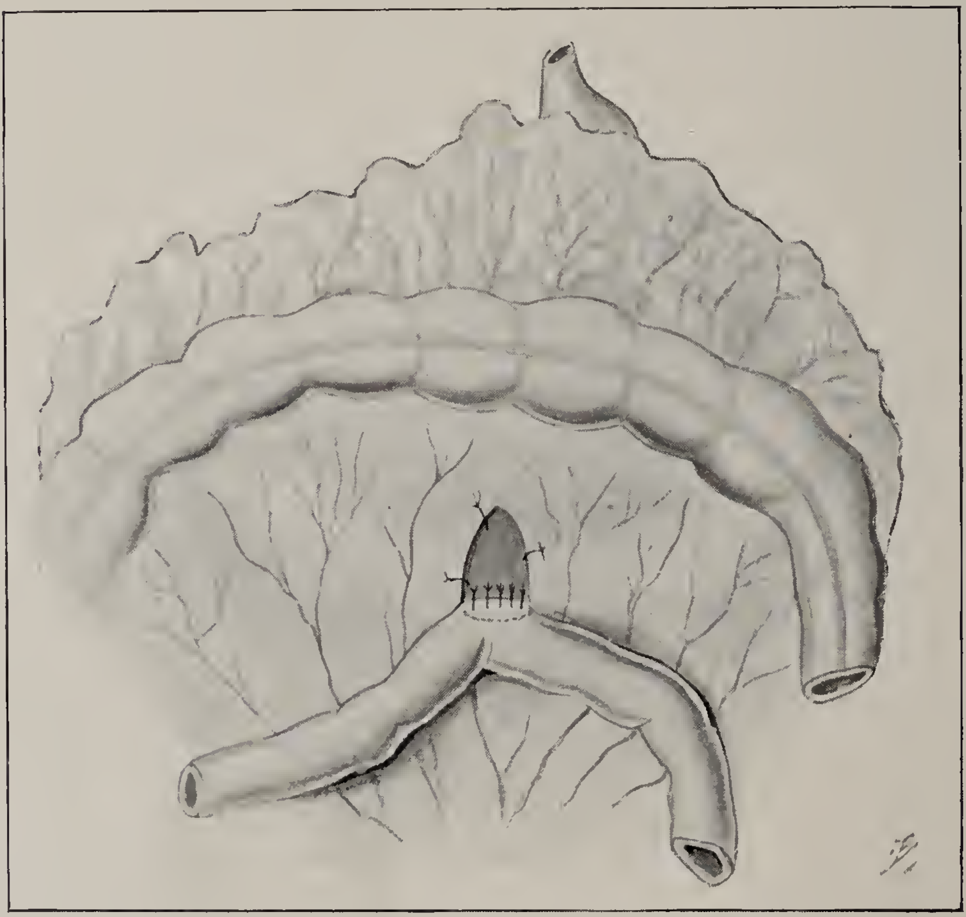

Fig. 454.—Hacker's Posterior Gastroenterostomy.

tape may be passed close to the gut through the mesentery above and below the point of proposed opening, carried around the gut, twisted, and secured by clamp forceps. The remainder of the abdominal cavity is isolated from the field of operation by gauze. The intestine is grasped by the thumb and forefinger of the left hand and a scratch line made an inch and a half long opposite the mesentery. A similar line is made in the posterior stomach wall in the center of the exposed area. The further steps of the operation are the same as in lateral enterorrhaphy (see page 71 and Figs. 439, 440, and 441).

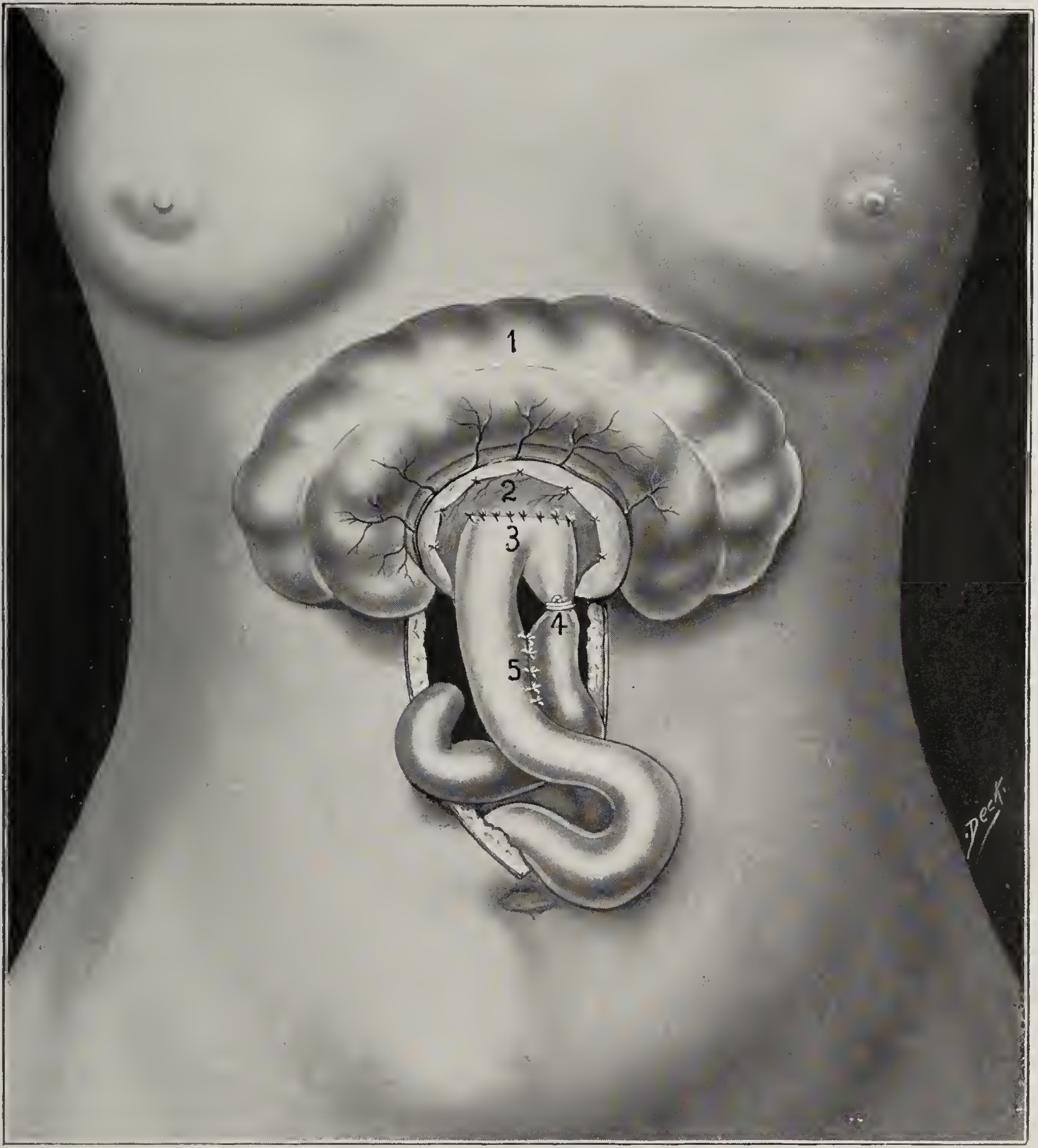

Fig. 455.—Gastroenterostomy with Enteroenterostomy and Circumclusion of the Afferent Portion of the Loop by Means of Silver Wire.

1, Transverse colon; 2, posterior wall of the stomach as it appears secured in the opening in the mesocolon (the opening in the mesocolon is shown larger than actually required); 3, the gastroenterostomy; 4, circumclusion of the afferent portion of the jejunum by a double silver wire ligature; 5, enteroenterostomy between the afferent and the efferent portion of the jejunum.

Vicious Circle.—This is a term applied to certain pathologic conditions following gastrojejunostomy, the symptom of which is the vomiting of ingesta mixed with bile and intestinal secretions. It results from the passage of the contents of the stomach into the duodenum through the afferent limb of the jejunum, instead of into the efferent limb; they accumulate until the duodenum becomes distended, when they are regurgitated into the stomach and vomited. It has been shown by experiments on animals (Kelling, of Dresden) that filling of the duodenum arrests contraction of the stomach as long as it continues. Therefore, in gastrojejunostomy patients, as long as the duodenum remains filled the stomach is incapable of emptying itself of whatever is placed in it during the intervals, and this, together with the regurgitated contents of the duodenum, is finally vomited, the patient literally starving to death, in spite of the opening which, under favorable circumstances, would carry the digested food from the stomach in the proper direction. After losing two patients from this post-operative complication, the first at St. Mary's Hospital and the other at the German Hospital, I adopted with success the expedient of making an **enteroenterostomy** between the afferent and the efferent portion of the jejunum (Jaboulay, McGraw) and adding to this circumclusion by a ligature of silver wire (No. 20) loosely applied to the efferent portion at a point between its communication with the stomach and the enteroenterostomy (Fig. 455).

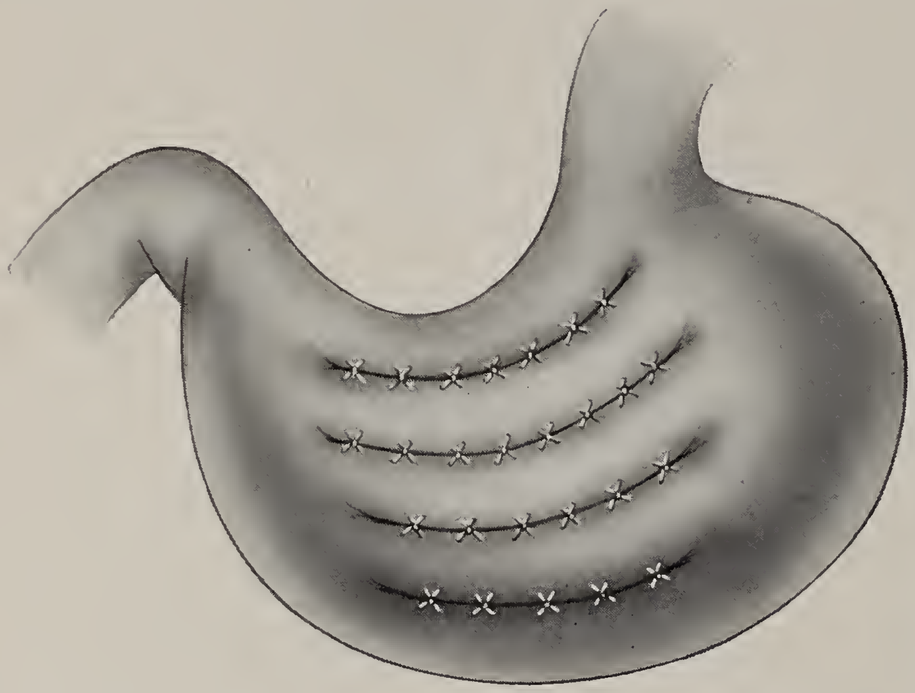

Fig. 456.—Brandt's Operation of Gastroplication.

The after-treatment of pyloroplasty and gastrojejunostomy is the same as that after gastrectomy (page 89).

Gastroplication.—This is a term given by Brandt to an operation for diminishing the size of a dilated or otherwise enlarged stomach. It was first performed by Bircher. Weir, of New York, without any knowledge of Bircher's three cases, operated successfully in one case. In Bircher's first case the greater curvature was sewed to the lesser curvature by a row of silk sutures, the stomach wall between the row of sutures being infolded. In his second case the fold was more vertically oblique. In Weir's case the essential steps of Brandt's method were followed; the gastroplication was effected by successive rows of sutures made in the long axis of the stomach. Brandt operated as follows: An incision 3 inches long was made parallel to the left costal arch. The stomach was identified and drawn out of the wound and

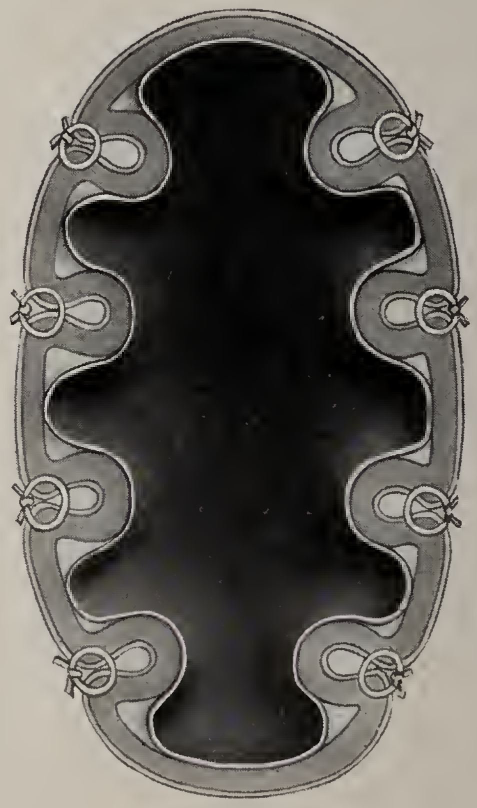

Fig. 457.—Gastroplication. Sectional View.

its exact condition determined. Its anterior wall was infolded and sutured in from two to four parallel lines, according to the amount of dilatation of the stomach (Fig. 456). According to Brandt, the peritoneum and the muscular layers of the stomach are easily lifted from the mucosa (Fig. 457).

Gastropexy.—This consists in replacing a displaced and dilated stomach, and retaining the viscus in position by suturing, at their normal levels, the pylorus and lesser curvature to the abdominal wall. Rivosing sutured the stomach to the anterior abdominal wall with three rows of removable silk sutures, scarifying between the sutures. Shortening the gastrohepatic and gastrophrenic ligaments by three rows of interrupted sutures has been successful (Beyea). The last-named procedure avoids suturing the stomach wall and the consequent risks of interference with the nutrition of that organ. I have accomplished the object in view by suturing the gastrocolic omentum to the anterior abdominal wall. This may be added to Beyea's method when the latter is available, or it may be applied alone.

Gastrogastrostomy.—It sometimes happens that a localized contraction of the stomach wall takes place at a point somewhere between the cardiac and the pyloric orifice, dividing the stomach into two separate pouches, or diverticula (**hour-glass contraction**). This may be remedied by effecting a broad communication between the two pouches by means of a free incision in each pouch which shall include the constriction, hemming the edges of each, and then uniting the opposing edges by their serous surfaces in such a manner that there shall be but one cavity to the stomach, instead of two (Watson).

INFLAMMATIONS OF THE INTESTINAL CANAL FROM THE SURGICAL STANDPOINT

With the exception of inflammations of the vermiform appendix, those of the intestinal canal in their original condition belong to the domain of internal medicine. Only isolated sequels of these conditions demand surgical treatment.

Ulcerative processes of the mucous membrane may require surgical intervention from **hemorrhage, perforation,** or the **pointing of suppurative processes externally.** Hemorrhage from the stomach (**hematemesis**) may sometimes be relieved by gastroenterostomy (Moynihan), or gastrectomy. Hemorrhage from **typhoid** ulceration occurs most frequently in the last 15 inches of the ileum. It has been proposed to reach this by abdominal section, with excision of the ulcerated and bleeding point, or resection. Otherwise, hemorrhage from the intestinal canal is inoperable, though saline infusion may be performed to tide the patient over until there is a possible arrest by nature's efforts and internal medication. **Perforation of the intestinal wall** may be due to typhoid, dysenteric, or tuberculous ulceration. The first named is the most frequent, as well as the most rapid in its development and fatal in its effects, fatal septic peritonitis usually following. A prompt abdominal section may save the patient. Mikulicz operated successfully by intestinal suture after sixty hours. In dysenteric or tuberculous ulceration, on the other hand, adhesions form more frequently, followed by abscesses which point externally and either discharge spontaneously or are opened. In tuberculous cases these abscesses frequently result in **fecal fistulas.**

In the **treatment of typhoid ulcer perforating into the free peritoneal cavity,** the abdomen is opened promptly; the ulcer excised, and the perforation sutured. The search should commence in the ileocecal region and continue along the ileum until the point of perforation is found. More than one ulcer may be present. The mortality is high on account of the virulence of the infection, the large amount and liquid character of the extravasation, which becomes widespread, the difficulties of the operation, the occasional existence of more than one ulcer, and, finally, the greatly debilitated condition of the patient (see Treatment of Peritonitis).

APPENDICITIS

Inflammation of the vermiform appendix, on account of the frequency of its occurrence and its dangers, is the most important disease of the abdominal cavity with which the surgeon has to deal.

Etiology.—At least half of the cases of appendicitis occur in persons under twenty-five years of age; males are more frequently attacked than females (80 per cent); it is rarely if ever the result of injury, and the presence alone of seeds of certain fruits in the appendix as an etiologic factor is a fallacy. Small fruit seeds, if accidentally present in liquid fecal matter as it enters the appendix, may, on desiccation of the fecal matter after its accidental imprisonment in the tube, form a roughened surface on the resultant fecal mass and produce slight abrasions of the mucous membrane, which may be followed by infection of the organ; but appendicitis occurs quite as frequently from other causes. Foreign bodies entering the appendix *may* produce appendicitis, but when a foreign body is found, either at operation or at autopsy, it is to be regarded as a clinical curiosity. In over 2000 operative cases of appendicitis coming under my observation, in only three instances could a body, which could at all be construed into being "foreign," be identified as the cause of the lesion. One of these was a gallstone, which had lodged in the appendiculocecal orifice and produced sloughing of the organ by pressure. In the other two instances the presence of concretions, which on section proved to be true **enteroliths,** seemed to be responsible for the attacks. Instances of appendicular injury and perforation of the appendix by foreign bodies, however, are not wanting. Mestivier reported such a case as early as 1759. Of such cases no fewer than 33 have been collected and reported (Mitchell). The foreign body is most frequently the common toilet-pin. The fact that appendicitis is more frequent among males than among females has been attributed to the fact that in females there is a larger blood-supply to the appendix through the appendiculo-ovarian ligament of Clado.

The most prominent etiologic factor in appendicitis is the occurrence of bacterial infection in a vestigial organ which, like others of its class, possesses but a low vital resistance and is susceptible to destructive changes on slight provocation. This provocation is furnished by slight abrasions of its mucous membrane from the presence of hardened fecal matter, by circulatory disturbances arising from angulation of the organ, and by pressure on it when it is situated to the outer side of the colon and between the latter and the lateral boundaries of the abdominal wall, where it is frequently found at operation. All of these render an organ, functionless through evolutionary changes, exceptionally vulnerable to bacterial infection, which is always at hand in its interior. The invasion of microorganisms occurs at the mucous membrane, soon involves the submucous layer of connective tissue, and from this point on may produce violent inflammation of the organ in its entirety, with destructive changes limited to one or more points (**ulceration**), which may go on to **perforation** into the free peritoneal cavity; **complete gangrene** may occur, or the orifice leading into the cecum may become closed by inflammatory swelling, or some portion of the lumen may have been closed as the result of a former attack, and accumulation of secretion undergoing suppurative changes ensue (**empyema of the appendix**).

To sum up, therefore, the disease is due (1) to the low vital resistance of an organ of a peculiarly vestigial character; (2) to infection from the presence of one or more of the intestinal microorganisms. Circulatory disturbances more or less readily produced by sharply curved or angular shapes of the organ, or a deficient or interrupted blood-supply, as well as the presence of accidentally imprisoned fecal matter which is prevented from returning to the cecum because of the feeble expulsive power of the tube or the narrowing of the latter, either congenital or otherwise, or both, still further increase the possibilities. This fecal matter, because of the bacterial infection which it conveys to the parts, or from the pressure effects following inspissation and a roughened surface, or both, contributes to the etiology of the disease in its entirety, and particularly in the cases in which perforation takes place. Operative experiences and post-mortem examinations show, however, that bacterial infection may occur independently of the presence of fecal matter, and that the presence of fecal concretions or foreign substances of any kind is not at all essential to ulceration, perforation, or gangrene.

Classification.—It is useless to attempt a classification of appendicitis on the basis of the pathologic changes occurring, as described in the last paragraph. So-called **catarrhal appendicitis,** or inflammation involving the mucous membrane alone, probably does not exist sufficiently long to be identified as such, and this term is therefore fallacious, as the submucous connective tissue is involved almost at once when the infection has taken place. What was "catarrhal" in one hour ceases to be so in the next; what was simple inflammation in the morning may become ulcerative by night, and perforative or gangrenous before the next morning. Suppurative appendicitis is likewise a misleading term, inasmuch as more or less suppurative inflammation occurs in all stages of the affection, except in those in which the organ breaks down into gangrene within a few hours. The whole matter may be summed up in the statement that an infection takes place from the interior of the organ, that this leads to a more or less violent inflammatory process that may lead to changes varying from simple interstitial round-cell infiltration to all the grades of suppuration, ulceration, local perforative sloughing, and complete gangrene of the organ. And no one may know in a given case, as far as the appendix itself is concerned, how far this process has extended, short of invasion of the peritoneal cavity itself.

Clinical Forms.—Inasmuch as there are different grades of severity and varying rates of progress of the inflammatory conditions present, it will be convenient for purposes of study and statement to classify the disease clinically as follows: (1) **hyperacute appendicitis,** or those cases in which the symptoms indicate a degree of virulence of infection and severity of inflammation unusual in the average acute case; (2) **acute appendicitis,** or those cases in which the onset is an average one, lacking the grave and immediately threatening features of the first form; (3) **subacute appendicitis,** or cases in which, both as regards onset and course, the symptoms are of a mild character, as compared with those of the first two; (4) **chronic** or **latent appendicitis,** usually the result of an acute or a subacute attack, but in which the appendix shows more or less tendency to relapse into a subacute or an acute attack; (5) **chronic relapsing appendicitis,** the form last described, but in which actual relapse takes place; (6) **recurrent appendicitis,** or cases in which the history shows that an existing attack was preceded by one or more attacks of the same disease.

The Symptoms and Course of Appendicitis.—In the great majority of cases the clinical course of the disease is characterized by the occurrence of **acute abdominal pain** at the outset. This pain is reflected in the distribution of the plexuses of Meissner and Auerbach, and referred to the neighborhood of the epigastric region, or somewhere about the umbilicus, more frequently than in the neighborhood of the appendix itself, where it is exceptionally complained of, and is very often diffused over the entire abdominal region. Later on, as the inflammation in the appendix increases and the peritoneum becomes involved, the pain may be felt in the right iliac region.

Coincidentally with the attack of pain, or shortly thereafter, **nausea** and **vomiting** frequently occur. These are purely reflex symptoms, but very constant. They are due to an irritation having its origin in the appendix. They cease when the stomach is emptied of its contents, but may return when other causes are brought into play to produce them, as, for instance, with the occurrence of perforative peritonitis. **Constipation** may precede or accompany the attack of appendicitis.

Tenderness in the right iliac region is an early, constant, and important symptom. There may be but a small tender area at first, and the location of the point of maximum tenderness may vary with the location of the appendix, but it will be most frequently found on the outer edge of the right rectus muscle, and about a fingerbreadth below a line drawn from the umbilicus to the tip of the anterior superior spinous process of the ilium (McBurney). This area of tenderness increases as the case progresses and more underlying peritoneum becomes involved; tenderness may also be elicited in the right iliac region when pressure is made on more distant parts of the abdomen. The tender area may be remote from the right iliac region, even approaching the left side, showing an abnormal position of the organ.

Rigidity of the right rectus abdominis muscle is an important symptom. The rigidity is particularly marked over the inflamed area, but may involve the entire muscle below the umbilicus. It is pronounced according to the extent of the involvement of the underlying peritoneal structures and the proximity of the latter to the anterior abdominal wall.

Tympanites from paretic distention of the adjacent coils of intestine takes place as the disease advances. With the spread of the peritoneal inflammation the coils of the intestine in the vicinity become more and more distended and new ones become involved in the paretic condition. A more or less distinct prominence on the right side may be noticed, though this may result from the presence of an abscess cavity or from an encysted serofibrinous exudation.

Rarely, in very thin subjects, the tumor made up of the inflamed appendix and a mass of adhesions is sufficiently pronounced to be observed by inspection.

In those cases in which the appendix passes into the pelvis and lies adjacent to the bladder, there may be **irritability of the bladder** from pericystitis. Where the inflamed appendix lies upon the iliopsoas muscle, there may be **retraction of the thigh.** This symptom, formerly looked on as the chief point in diagnosis, is but seldom observed.

Chill is not often observed as a primary symptom; later on it may mark the occurrence of suppuration. The **pulse** and **temperature** vary greatly in different cases, and do not bear a very definite relation to the severity of the attack. Their warnings are not to be disregarded, but the absence of such warning is not to be looked upon as a necessarily favorable sign. Perforation may occur, for instance, into the free peritoneal cavity, in a rapidly progressive ulcerative case, with a pulse of 80 and a temperature of 99° F. In the average case there is an elevation of temperature of from one to three degrees Fahrenheit.

An increase of all the symptoms occurs as the case goes on to peritonitis, with increased abdominal pain (unless this symptom is masked by the administration of opium), increasing distention, progressive prostration, rapid and weak pulse, pinched features, vomiting, dorsal decubitus with drawn-up knees, tense, rounded abdomen, obstipation, hiccough, cold and clammy sweat, and lethal exit (see Peritonitis, page 34).

In more favorable cases there may occur seropurulent collections, or true **appendicular abscesses** where suppuration takes place in the mass of new connective-tissue formation immediately adjacent to the appendix. The former may be very large and still be walled off from the peritoneal cavity. Purulent collections may find their way into the adjoining intestine and form a communication between the intestinal canal and the appendix itself (**pathologic anastomosis**). Extraperitoneal evacuation may occur into the rectum, the vagina, or the bladder; the purulent collection may follow the sheath of the psoas muscle after perforating posteriorly, and reach the thigh, or it may follow the line of the vessels over the pelvic brim and appear at the anal opening. Finally, it may point in the direction of the anterior abdominal wall (see page 25). The collection of pus may find its way through the diaphragm and cause suppurative pleuritis, or perforate the base of the lung after the formation of adhesions and finally escape through a bronchus.

Complications of Appendicitis.—Chief among these is the occurrence of peritonitis, including (1) the **perforative form,** in which direct infection occurs from the appendix itself; (2) the **infectious form,** caused by an extension of infection from a focus of suppuration about the appendix, or occurring post-operatively; (3) **tuberculous peritonitis,** most frequently the fibrous form of Aldibert. This is a feature of some of the subacute and chronic cases, and the lesion of the appendix may be only an incidental feature of the tuberculous peritonitis. In an acute attack of appendicitis in connection with the latter, this is due to the occurrence of ulcerative tuberculous foci in the peritoneum covering the appendix, with resulting tissue necrosis (for the Treatment of Peritonitis, see page 38).

Hematemesis.—This complication arises from minute points of ulceration on the gastric mucosa from plugging of the gastric terminal vessels by infectious emboli derived from the appendicular focus (Van Cott). The symptoms are persistent vomiting of dark brown or black material consisting of altered blood, and marked prostration. The prognosis is unfavorable, but few patients recovering after the pronounced symptoms set in. The treatment consists of repeated lavage with alkaline solutions, and supporting measures.

Suppurative hepatitis follows displacement of septic thrombi in the mesenteric veins, and these are carried into the portal vein and thence to the liver, where they lodge and form septic foci (**septic emboli**). **Purulent pericarditis** may occur as a result of hepatic abscess, the pus finding its way to the pericardium. **Purulent pleuritis** may occur in the same way. **Iliac phlebitis** with thrombosis and edema of one or both of the lower extremities occurs in a certain proportion of cases. The displacement of septic thrombi in this situation may give rise to such sequels as **pulmonary thrombosis** and **septic pneumonia.**

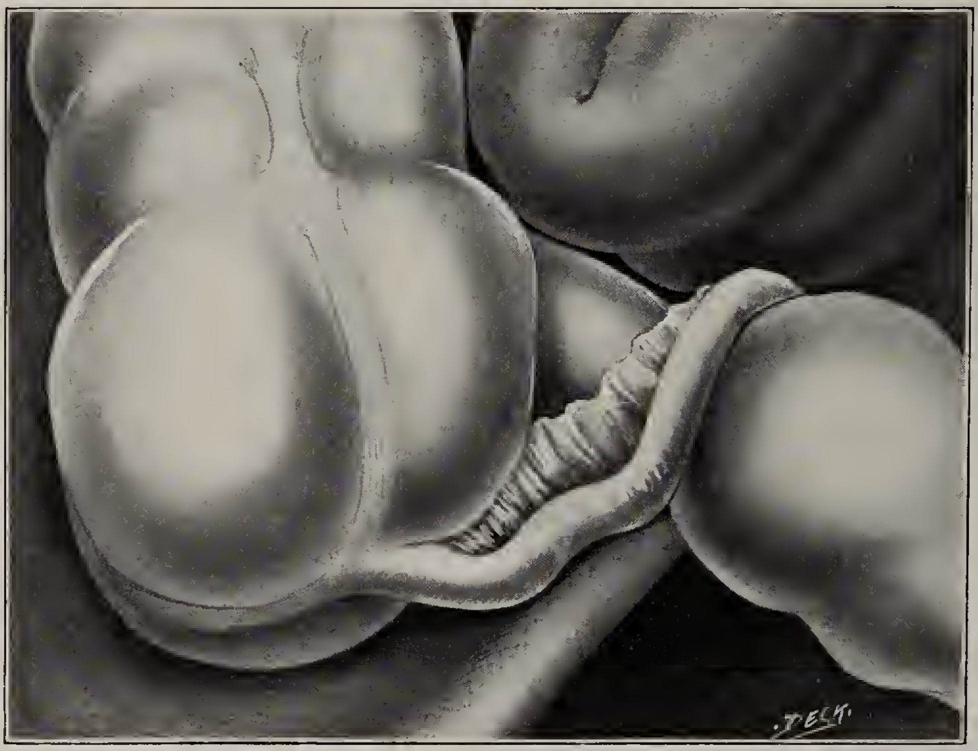

Fig. 458.—One of the Original Positions of the Appendix, Favoring Intestinal Obstruction (after Testut).

An inflamed appendix may be found in the **sac** of either **an inguinal** or **a femoral hernia,** alone or with the cecum. In a case coming under my care about one-half of the appendix and its mesentery had entered a small crural opening, where it became strangulated and gave rise to symptoms of an inflamed femoral hernia. **Appendicitis occurring during pregnancy** is an important complication of the latter, and may easily lead to the loss of both mother and child, unless diagnosed and operated on early. If it occurs during the **puerperal state,** the latter may throw the attendant off his guard, the symptoms being attributed to some essential complication of the puerperal condition.

Intestinal obstruction is an important complication of appendicitis; angulation the result of local peritonitis and the formation of vicious adhesions between adjacent coils of intestine, or adhesions between these and the appendix itself, is the most common cause of the obstruction. An adjacent coil of small intestine may be encircled by the appendix, which, becoming adherent at its extremity, acts as a constricting band. The original position of the appendix shown in Fig. 458 will favor this.

The Diagnosis of Appendicitis.—The diagnosis of acute appendicitis is based on the following: (1) the **suddenness** of the attack; (2) the occurrence of **acute abdominal pain**; (3) the occurrence of **nausea and vomiting,** either accompanying or following the pain; (4) **tenderness** at the site of the appendix.

A diagnostic point in connection with the pain is the fact that in the great majority of cases it is **referred to the region of the umbilicus or the epigastrium,** becoming located later in the right iliac region. Opium destroys its value in diagnosis.

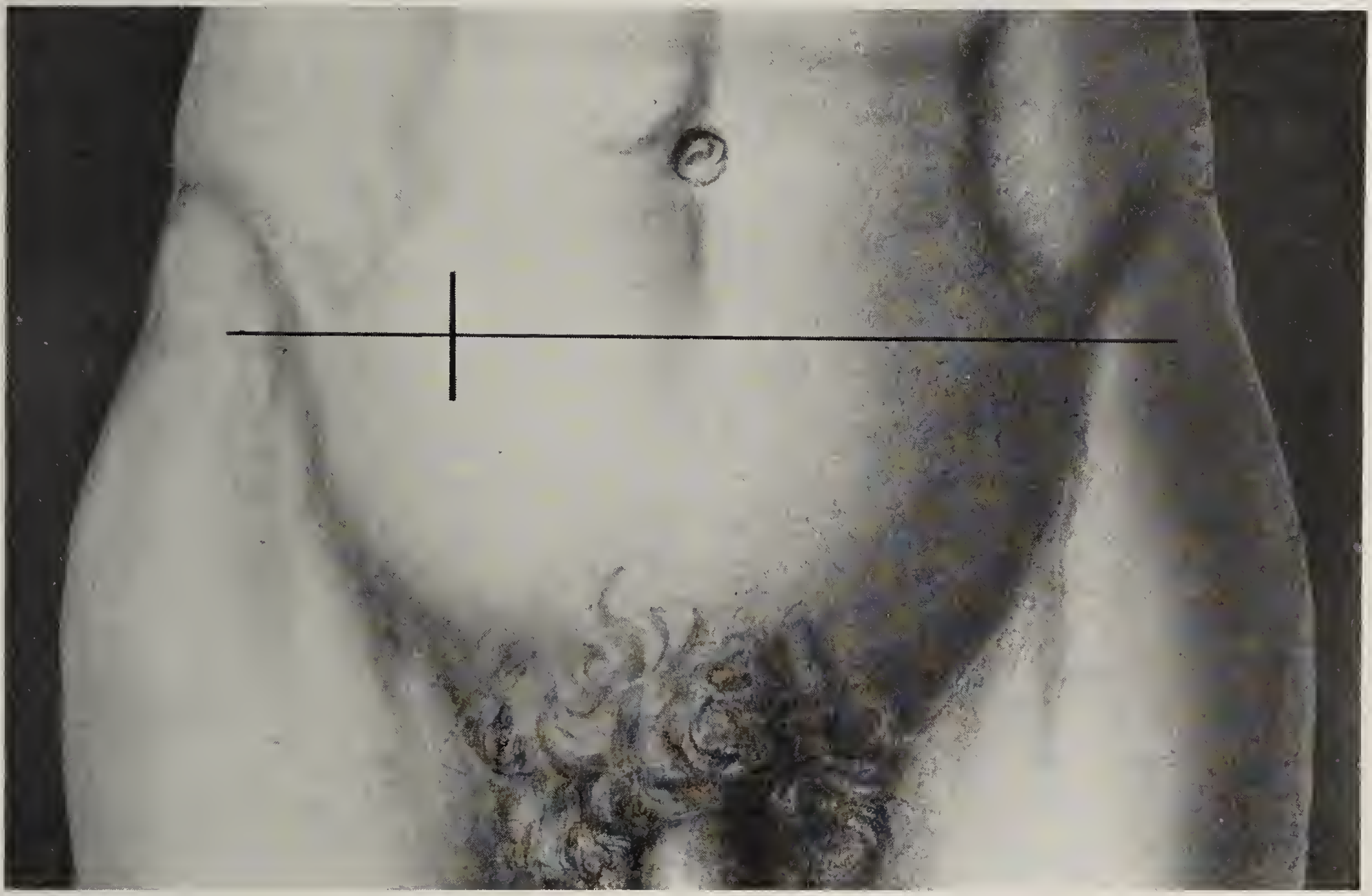

Fig. 459.—Intersecting Lines showing the Surface Relations of the Base of the Vermiform Appendix, Where Tenderness is Usually Most Pronounced.

The vomiting is not that of indigestion, though the fact of its occurrence in connection with pain in the epigastrium has led to many diagnostic errors.

Limitation of movement of the abdominal muscles during respiration, particularly on the right side, is frequently present. Opium likewise destroys the value of this symptom.

Tenderness in the right iliac region, when pronounced, is the most valuable of all the signs of appendicitis, both in diagnosing and in estimating the progress of the disease. Standing on the patient's right, the examiner places the thumb of his left hand on the anterior superior spinous process of the ilium, and the tip of his middle finger on the umbilicus. The index-finger, directed backward, will touch the spot where pressure will elicit tenderness in the average case (McBurney's point). The point of tenderness may vary in different cases, but with the appendix in its normal location it usually corresponds to the outer edge of the right rectus muscle at the level of the upper border of the anterior superior spinous process of the ilium (Fig. 459). The tenderness finally extends in the direction of Poupart's ligament.

Rigidity of the Right Rectus Muscle.—This is a marked feature in the majority of cases. Comparisons made by stroking with the fingers gently but firmly across the fibers of the rectus muscle of each side will usually elicit relatively increased tension on the right side, even in comparatively mild cases. **Palpation of the appendix** is delusive in healthy conditions of the organ and dangerous in diseased conditions. **Palpation through the rectum** (Treves) will rarely give information which cannot be otherwise obtained. Examination through the vagina is of value in differentiating appendicitis and right-sided inflammatory lesions of the adnexa.

Tumor.—The presence of a tumor may be made out, by both palpation and percussion, if the disease has advanced to the third day. The rigidity of the right rectus muscle may mask it to palpation, but a dull and high-pitched percussion-note will reveal it. A similar note is elicited also by the presence of a suppurative collection. Care should be taken to eliminate the possibilities of fecal impaction. In appendicitis the tumor is fixed and tender. In impaction of the colon it is also fixed, but it is less sensitive, as a rule, and follows the course of the colon. A movable and comparatively insensitive tumor in this region is characteristic of cancer of the bowel. Exceptions to this occur.

For the diagnostic value of Examination of the Blood see page 248, volume I.

The **differential diagnosis** in acute appendicitis must eliminate the following:

1. Gall-bladder lesions.
2. Subphrenic peritonitis.
3. Acute intestinal obstruction.
4. Perityphlitis and paratyphlitis.
5. Ruptured pyosalpinx.
6. Ruptured ovarian cystoma.
7. Ruptured ectopic gestation (pelvic hematoma).
8. Acute torsion of right ovarian cystoma.
9. Torsion of right-sided hydrosalpinx.
10. Right-sided hematosalpinx.
11. Acute peritonitis.
12. Paroxysms of pain due to right-sided movable kidney and to nephritic colic.

In chronic appendicitis the following should be differentiated:

1. Abscess in the abdominal wall.
2. Impacted ureteral calculus.
3. Fecal impaction.
4. Tubo-ovarian inflammation.
5. Carcinoma in the ileocecal region.
6. Retroperitoneal sarcoma presenting in the right iliac fossa.

The Prognosis of Appendicitis.—The prognosis of appendicitis is unfavorable in the cases treated without operation in proportion to the severity of the infection; in the cases treated operatively, other things being equal, the prognosis is unfavorable in proportion to the delay in performing the operation. While there are doubtless many cases of a mild character which recover without operation, it is equally true that a very large number of the cases which are lost, both with and without operation, were mild cases in the beginning of the attack. Of those which recover under the expectant method of treatment, not less than 30 per cent suffer recurrences (Dörfler). There is a time in the history of every case of appendicitis when operative treatment can be instituted with a mortality risk not greater than 1 in 200. On the other hand, many cases are finally turned over to the surgeon by the medical practitioner with not one chance in 200 for recovery.

Constantly increasing experience teaches that the only certain feature about appendicitis is the uncertainty of its termination under so-called medical treatment, or when operation is delayed. The prognosis in cases subjected to operation will vary with the stage of the case at which this is undertaken. Early acute cases, in which the infection is confined to the appendix itself, as well as subacute and chronic cases, in the hands of an aseptic surgeon show a high percentage of recoveries. On the other hand, the most skilfully performed operation will fail to rescue many of those in whom general septic peritonitis, or septicopyemic general infection exists.

The Surgical Treatment of Appendicitis.—As soon as the diagnosis of **progressive appendicitis** is assured, the abdominal cavity should be opened and the appendix removed. By progressive appendicitis is meant a condition in which, with no opium administered, decided tenderness exists in the right iliac fossa at the end of twenty-four hours from the commencement of the attack. If opium has been injudiciously administered and the progressive character of the case is in doubt, it is better to err on the side of safety and operate. In subacute and chronic cases the operation may be performed at any time, no contraindications existing; in chronic relapsing cases, as well as in the cases in which a history of two or more indubitable attacks is obtained, advantage should be taken of the first period when the appendix is free from active infection to remove the organ.

The most varying conditions will be found in different cases, including simple inflammation of the mucosa and submucosa; commencing ulcerative action in patches here and there on the mucosa; infiltration of the walls of the appendix and more or less rigidity of the organ; deep ulceration with attempts at protection by lymph-patches on the exterior of the organ; stricture of the lumen or stenosis at the appendiculocecal orifice, and accumulation of infectious material consisting of mucopurulent material mixed with fecal matter (empyema of the appendix); perforation by ulceration with (*a*) surrounding adhesions, with subsequent suppuration (appendicular abscess), or (*b*) absence of adhesions and infection of the general peritoneal cavity; gangrene of the organ in whole or in part, including the sloughing away of a portion through involvement of all its coats; gangrene of the walls of the organ alone, or gangrene of the mucous membrane alone; localized collections of seropurulent material; more or less spreading, or diffuse peritonitis; finally, general septic peritonitis. The surgeon must be prepared to meet with any of these conditions, and perhaps with several of them coexisting, in most of the cases with which he has to deal. The ease and facility with which the appendix can be removed in early cases is in striking contrast with the difficulties which try the skill of the most experienced surgeon in late operations.

In considering the question of operative interference cases of appendicitis may be classified as follows:

1. Cases in which an abscess, formed in a mass of adhesions, requires only opening. It is frequently not possible to remove the appendix with safety in this class of cases.

2. Cases which hold out a reasonable hope that the appendix can be removed with safety, though infection beyond the organ itself is present. The conditions permitting this obtain from about the second to the fourth day.

3. (*a*) Cases in which the operation may be undertaken sufficiently early in an attack (before or at the end of the first twenty-four hours) to give a reasonable assurance that the attack is confined to the appendix; (*b*) cases which may be operated on after the subsidence of an attack and during the period of quiescence.

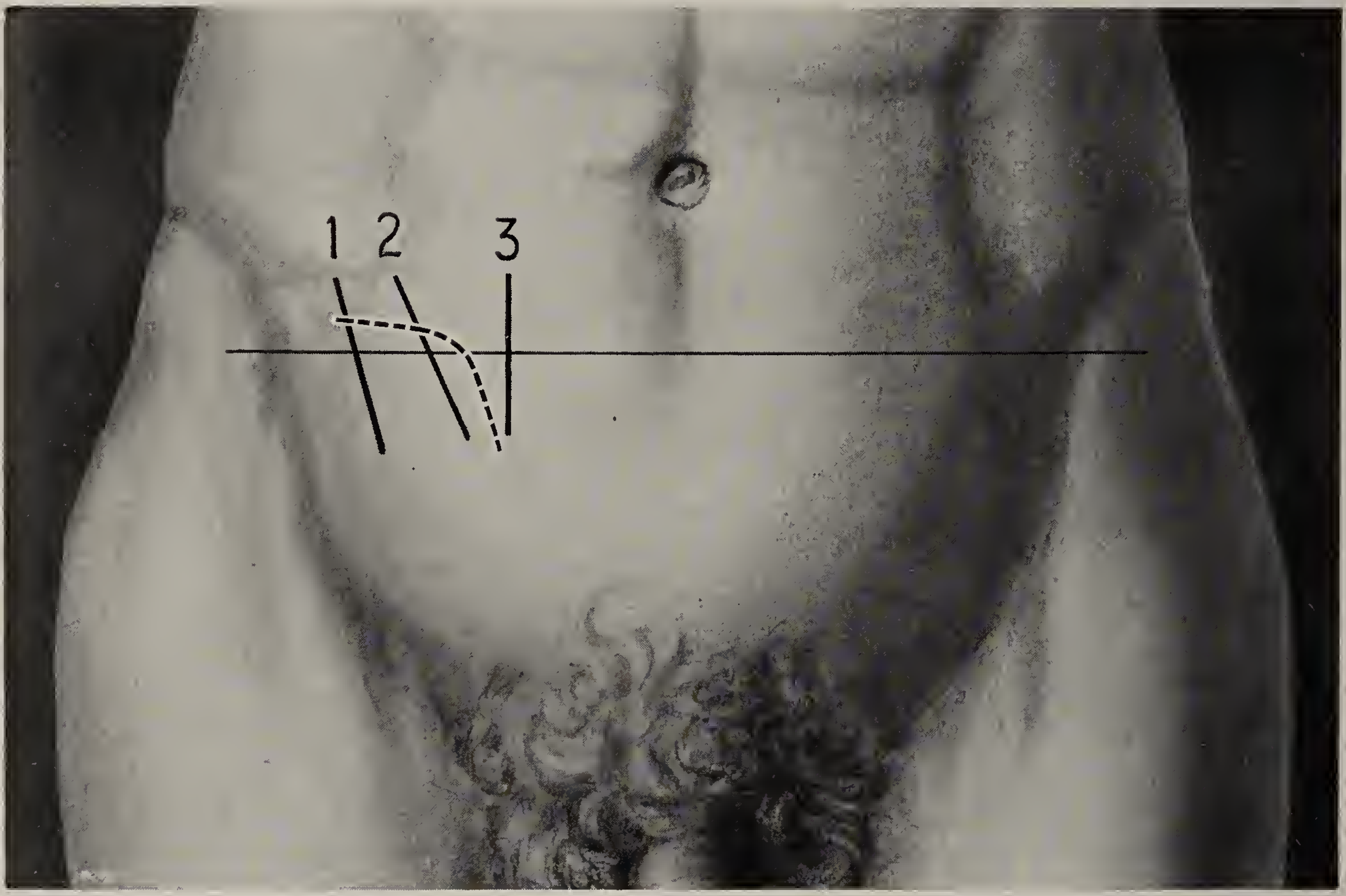

Fig. 460.—Lines of Incision for Operations on the Vermiform Appendix.

1, The line for McBurney's intermuscular method; 2, the line for the oblique incision; 3, the line for the vertical incision. The broken curved line represents the line of incision for the author's intermuscular method.

In addition, cases of doubtful diagnosis require an operation more or less exploratory in character, investigation being directed not only to the appendicular region, but to the region of the gall-bladder in males, and to both this and the pelvic cavity in the female.

The operation in all cases must be carried out with every aseptic and antiseptic care, even in those cases in which the peritoneum is known to be already infected.

The Choice of Operation.—Two points must be borne in mind in selecting the site and method of incision in operations for appendicitis; (1) the appendix must be brought readily within reach; (2) weakening of the abdominal wall must be avoided by carrying the incision in the direction of the fibers of important muscular structures in the abdominal wall whenever practicable. The presence of infectious material about the appendix and the necessity for ample room for the operative procedure, as well as for drainage, may make it necessary to sacrifice all other considerations.

Practically, two operative methods are available, as follows: (1) the operation by the oblique incision; (2) the intermuscular methods. In cases in which drainage will be required the oblique incision through the right linea semilunaris should be employed. Cases in which drainage will not be required should be operated on by one of the intermuscular methods. In exploratory cases the ends of the oblique incision may be extended upon the edge of the rectus in an upward or downward direction, or a vertical incision may be made at first. In cases free from pus a modified Trendelenburg position may be employed.

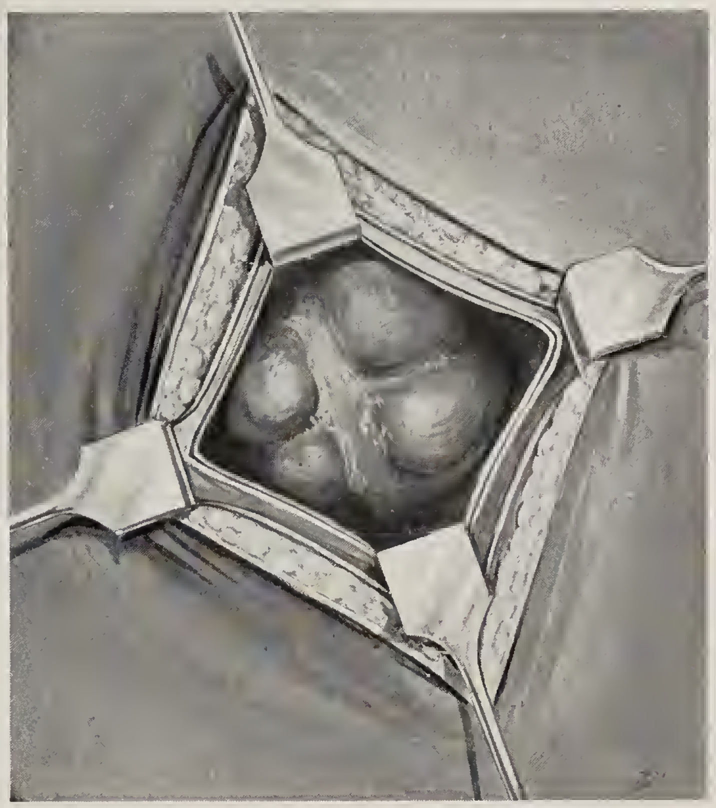

Fig. 461.—McBurney's Intermuscular Method. Showing the aponeurosis of the external oblique muscle incised in the direction of its fibers and retracted laterally and the internal oblique, the transversalis muscle and transversalis fascia, and the peritoneum incised transversely and retracted in a vertical direction.

The Operation by the Oblique Incision.—This incision aims to enter the abdominal cavity through the right linea semilunaris (Fig. 460, 2). Should the latter not appear prominently, as frequently happens, the deeper dissection may be made by opening the sheath of the rectus and entering the abdominal cavity behind the latter. The incision commences about an inch above a line drawn from the umbilicus to the anterior superior spinous process of the ilium, and is carried downward and inward for 2½ inches, the middle of the line resting on a point corresponding to the intersection of the vertical with the transverse line shown in Fig. 459. The aponeurosis of the external oblique is cleared and incised in the direction of its fibers. The edges are retracted and the linea semilunaris incised if this can be identified. More frequently, however, the incision through the aponeurosis of the internal oblique opens the sheath of the rectus muscle. The incision now deepens until the peritoneum is reached, when this is grasped by two pairs of dissecting forceps, one pair being in the hands of an assistant, and carefully incised; the finger is then introduced as a guide in completing the incision.

The Operation by Intermuscular Methods.—The abdomen is entered through the musculo-aponeurotic structures of the abdominal wall by a separation of these in the direction of their fibers. In McBurney's method the skin incision is made parallel to the oblique incision and somewhat to the outer side of the appendix (Fig. 460, 1). The space gained is somewhat

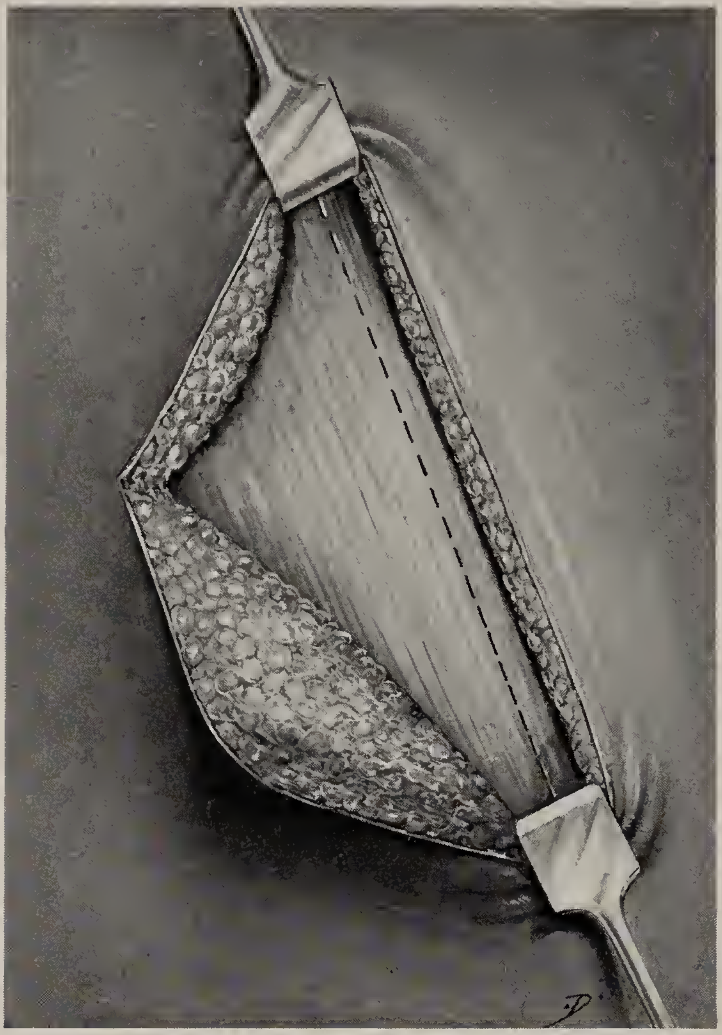

FIG. 462.—THE AUTHOR'S INTERMUSCULAR METHOD.

The aponeurosis of the external oblique exposed. The dotted line shows the place of the incision in this structure.

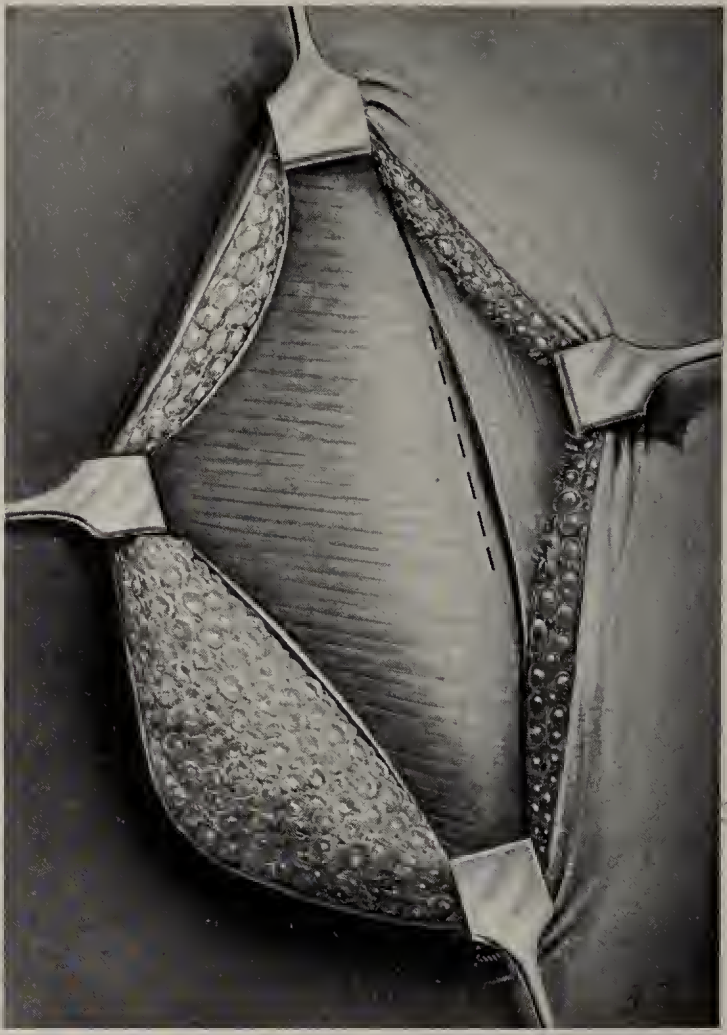

FIG. 463.—THE AUTHOR'S INTERMUSCULAR METHOD.

The dotted line shows the site of the incision in the sheath of the rectus muscle.

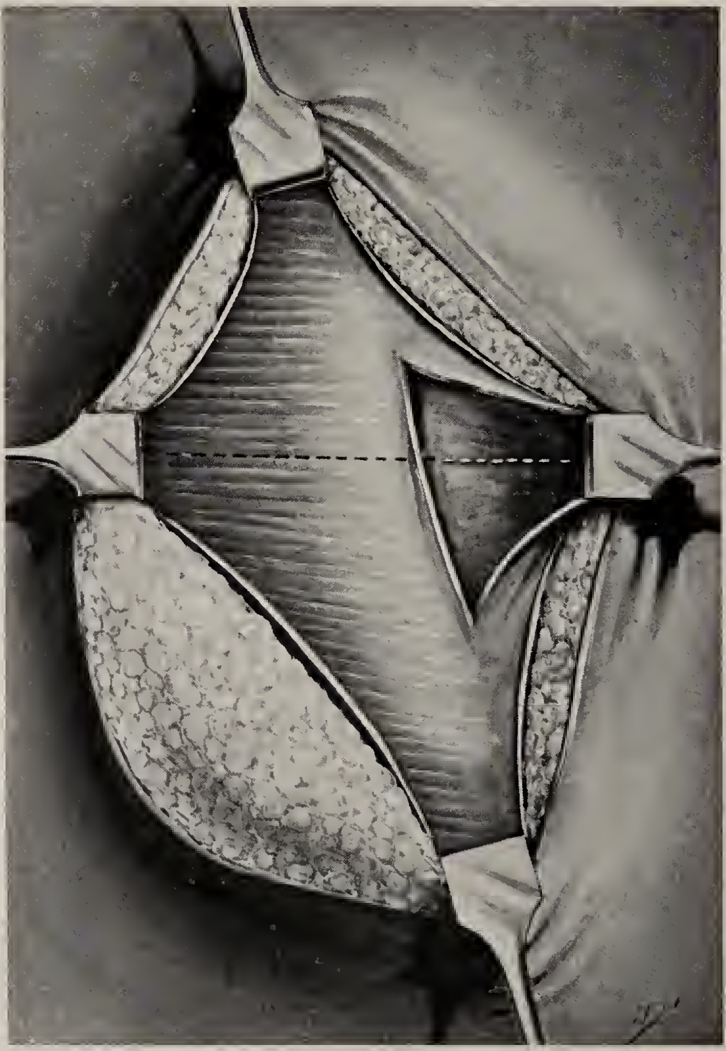

FIG. 464.—THE AUTHOR'S INTERMUSCULAR METHOD.

The site of the transverse incision.

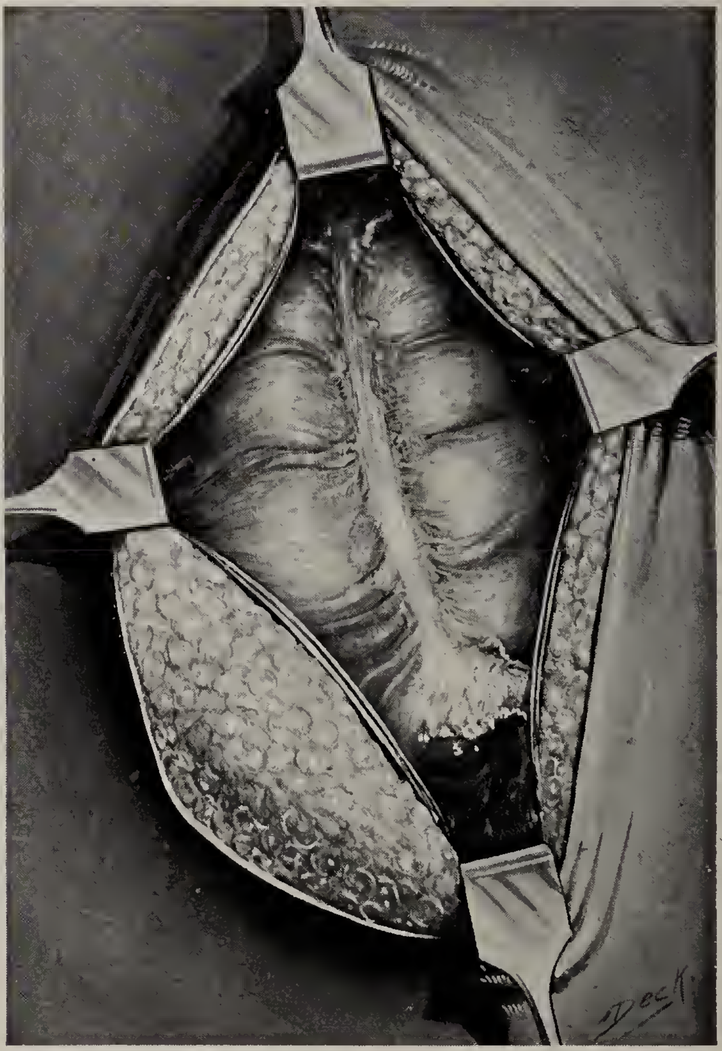

FIG. 465.—THE AUTHOR'S INTERMUSCULAR METHOD.

The opening in the abdomen.

limited (Fig. 461). The operation devised by the author is based on the same principles but gives better access and removes the skin incision from direct relation with the line of incision in the external oblique aponeurosis. The increased working space is gained by carrying the inner portion of the transverse incision behind the rectus muscle, and extending it, if necessary, to the median line. When sutured, this latter portion of the line of

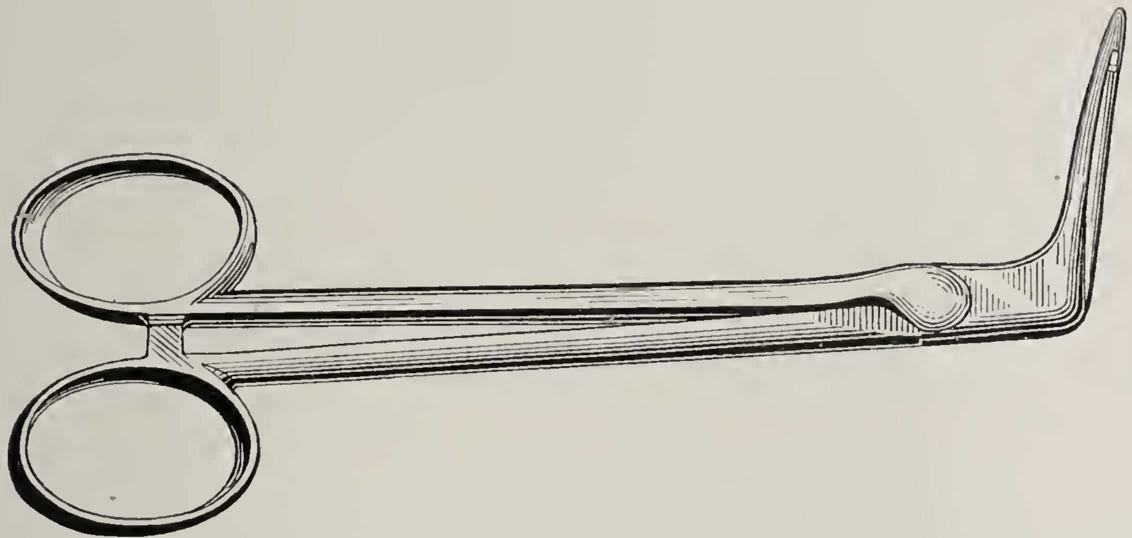

Fig. 466.—Short Ligature-carrier for Ligating the Meso-appendix.

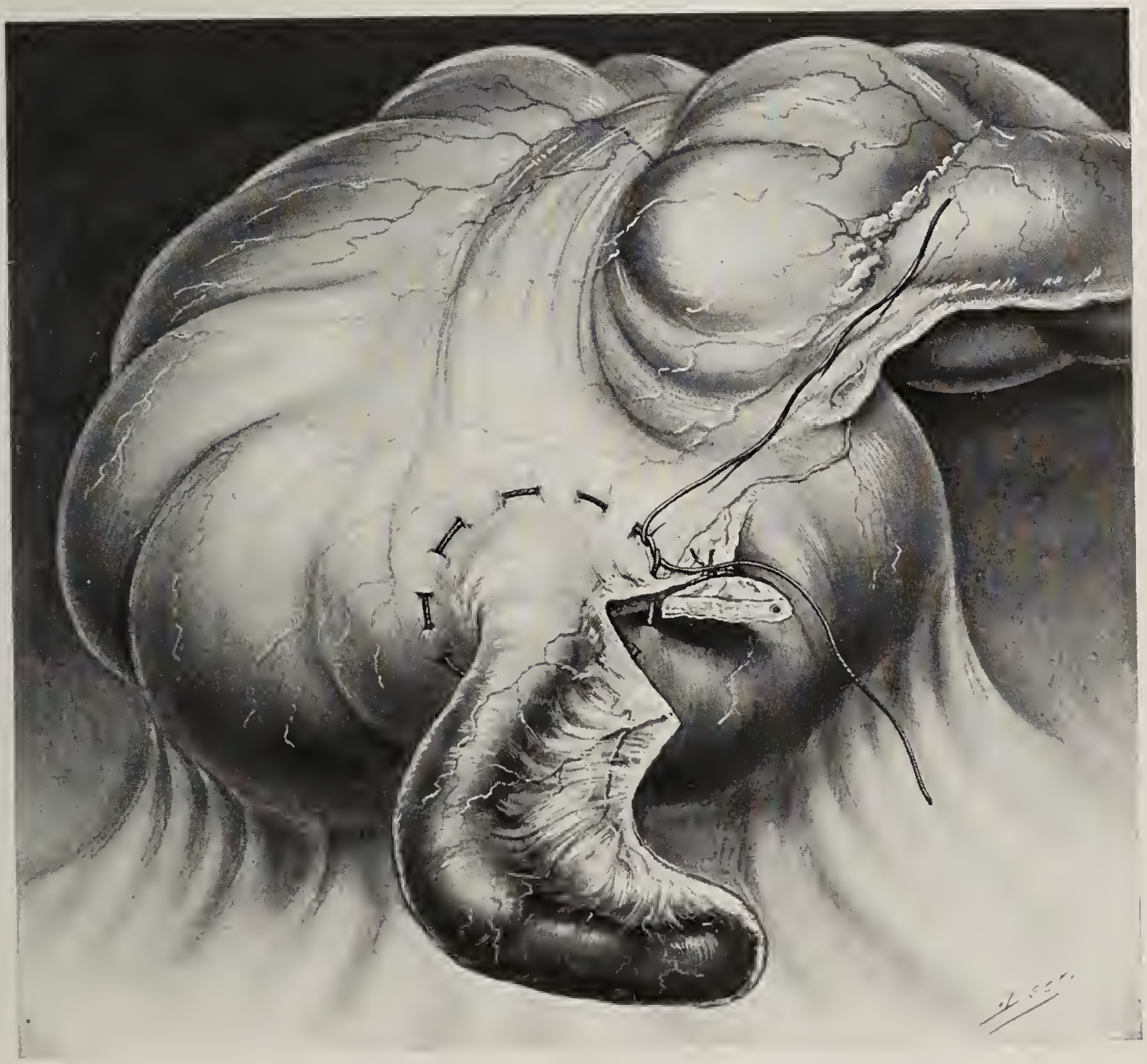

Fig. 467.—The Application of the Pursestring Suture.

incision is supported by the overlying rectus muscle. One half of the skin incision is placed nearly at right angles to the incision in the external oblique, while the other half is well to the inner side of the latter. In this manner the "break-joint" feature of the intermuscular method is more completely carried out and risks of infection of the suture line of the aponeurosis of the external oblique are diminished. The skin incision commences about an inch to the inner side of the upper rounded prominence of the anterior superior spinous process of the ilium, is carried horizontally to the outer edge of the rectus, from which point it curves downward and is extended parallel to the edge of the latter for a distance of about 2½ inches (Fig. 460). The skin, fat, and fascia are reflected and retractors applied so as to bring the incision in the shape shown in Fig. 462 and expose the aponeurosis of the external oblique. This is incised as shown by the dotted line in Fig. 462, and two more retractors applied, exposing the aponeurosis of the internal oblique, and the sheath of the rectus muscle at the site of the dotted line shown in Fig. 463. The sheath of the rectus muscle is incised as shown by the dotted line and the rectus muscle and deep epigastric artery and veins are well retracted toward the median line, the outer incised edge of the aponeurosis of the external oblique retracted in an outward direction, and the transverse incision made in the direction of the dotted line shown in Fig. 464, the incision

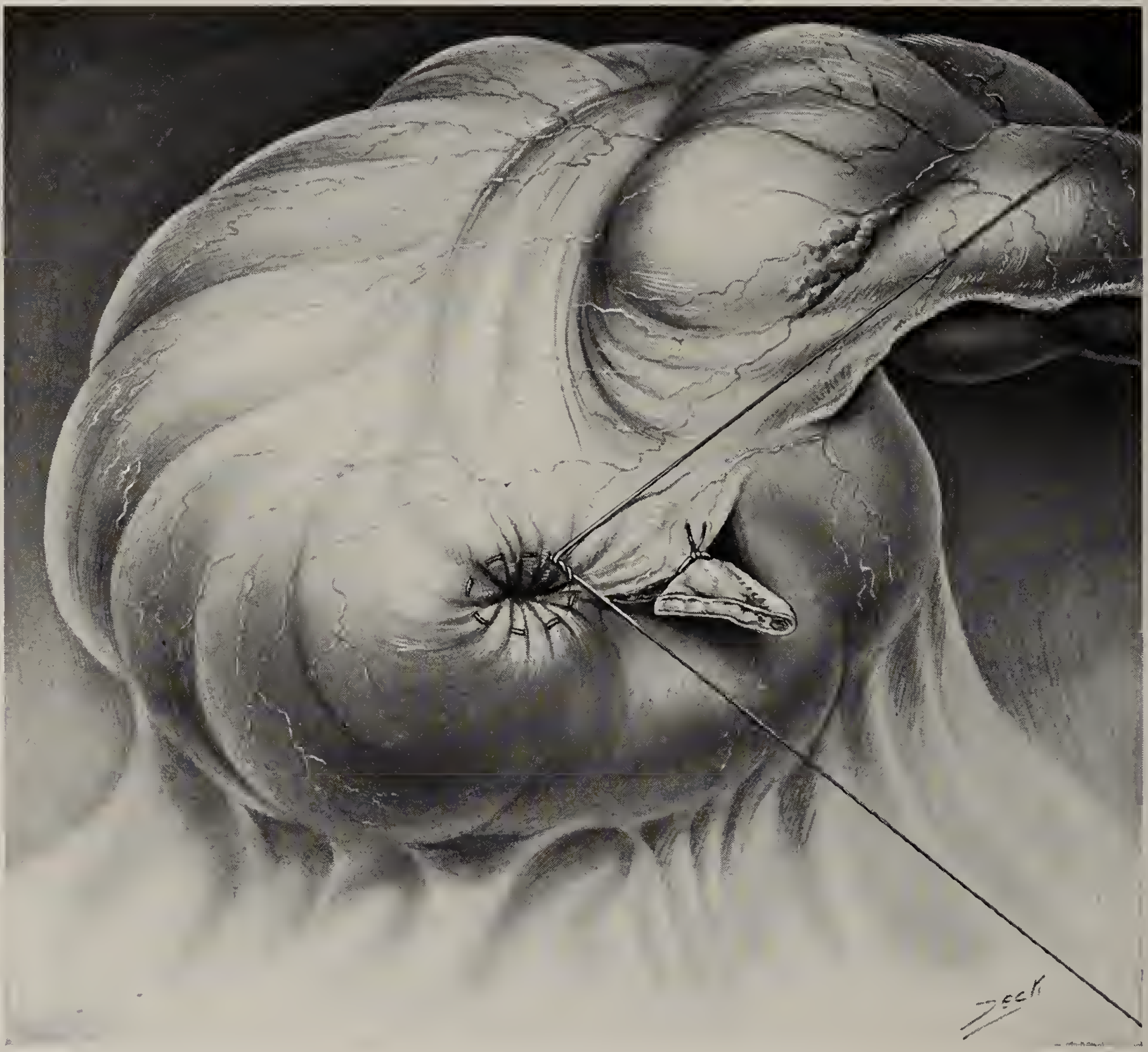

Fig. 468.—The Appendix Has Been Cut Away, the Edges of the Opening in the Cecal Wall Inverted, and the Pursestring Suture Tightened.

including the aponeurosis of the internal oblique and its outer muscular portion, the transversalis fascia and the peritoneum. Retraction of the edges of the transverse incision gives free access to the ileocecal region (Fig. 465).

In the **vertical incision** the skin incision corresponds to the outer edge of the rectus muscle and the sheath of the latter is exposed and incised. The muscle is drawn to one side, together with the vessels, and the posterior portion of the sheath and remaining structures incised to open the peritoneal cavity.

The **intra-abdominal technic** includes isolation of the intra-abdominal operating field by gauze pads, wet with 1:2000 corrosive sublimate solution if pus is present. A self-retaining retractor is of advantage (Fig. 413). If a gush of pus occurs, this is wiped away gently but rapidly and search made for the appendix, which, when found, is isolated from adhesions by the fingers and dealt with by first ligating the meso-appendix, then separating it from the appendix, and applying a pursestring suture on the cecal wall (Dawbarn) about three-eighths of an inch from the base of the appendix, this suture including the serous and muscular coats of the cecum (Fig. 467). The appendix is now cut away, preferably by the thermocautery, for aseptic and hemostatic reasons, the edges of the opening in the cecal wall inverted, and the pursestring suture tightened, the suture thus approximating the serous surfaces of the cecum (Fig. 468). The stump of the meso-appendix is placed over the depression left by the

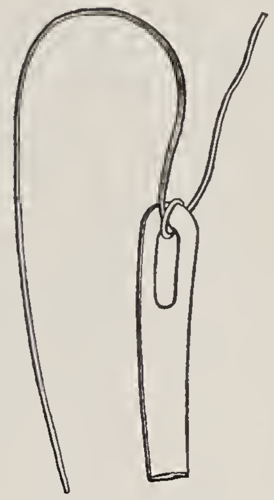

Fig. 469.—Method of Securing the Suture of Silkworm-gut to the Needle.

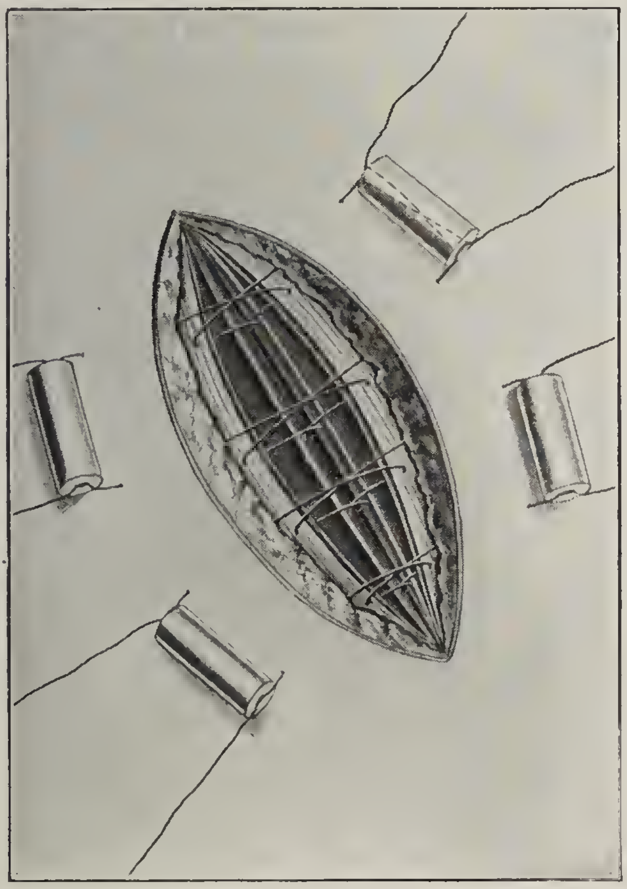

Fig. 470.—The Figure-of-8 Removable Layer Suture.

Showing the direction taken by the sutures in grasping the edges of the different layers.

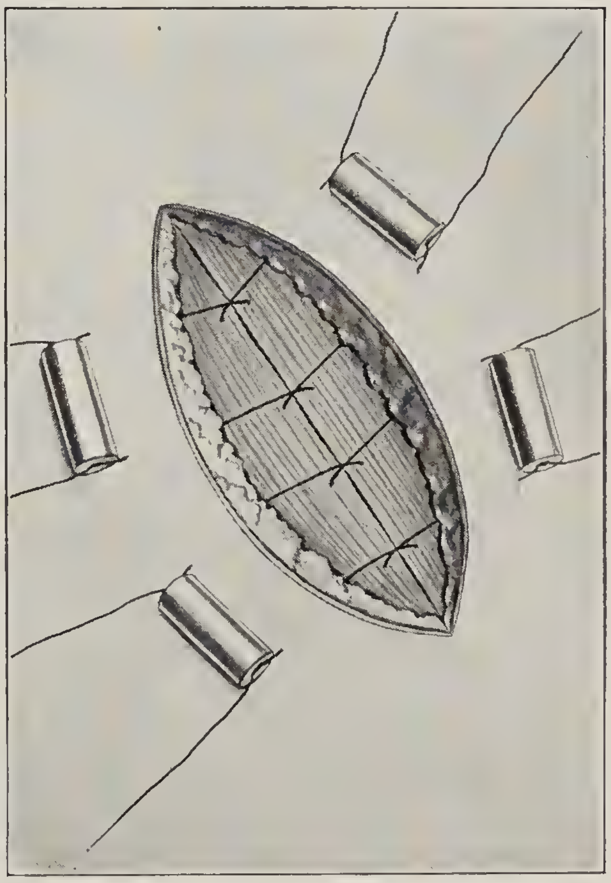

Fig. 471.—The Figure-of-8 Removable Layer Suture.

Showing the appearance of the wound with the sutures drawn taut.

inversion of the cecal wall, where it is secured by tying over it the ends of the pursestring suture. Any spot on the cecum threatening gangrene should be included in a separate pursestring suture, as suggested by Dawbarn.

Closing the Abdominal Wound.—If no infection is present and the incision in the peritoneum is 2½ inches long or less, the peritoneal surfaces may be approximated by a pursestring suture (Doyen). Where only a small drain is required, this may be carried in an outward direction through a stab wound made from the direction of the loin with the finger in the peritoneal cavity for a guide and for the prevention of injury to the colon. A rubber drainage-tube with a small strip of gauze passed through it answers best for this. (For drainage in septic peritonitis, see page 40.) A figure-of-8 removable layer suture of silkworm-gut is employed with advantage in closing the muscular and aponeurotic layers of the abdominal wound, particularly in septic cases; the incision in the peritoneum may be closed by a continuous suture of chromicized catgut if the pursestring suture is not applicable for this. When the figure-of-8 removable layer suture is employed the strands of silkworm-gut are armed with two needles, which are secured as shown in Fig. 469. The manner of passing and securing the removable layer or "cross suture" is shown in Figs. 105, 106, 107, 470, and 471. These sutures are prevented from making undue pressure and from coming in contact with the edges of the skin by wound using "bolsters" of rubber tubing, and by tying them in pairs. In strictly aseptic cases, *i. e.*, where the infection has not extended beyond the appendix and no undue strain on the abdominal wall from tympanitic distention, etc., is to be feared, the layer suture of chromicized catgut may be employed throughout, except at the skin edges. The skin wound is closed by the intra-cuticular suture (Kendal Franks, H. O.

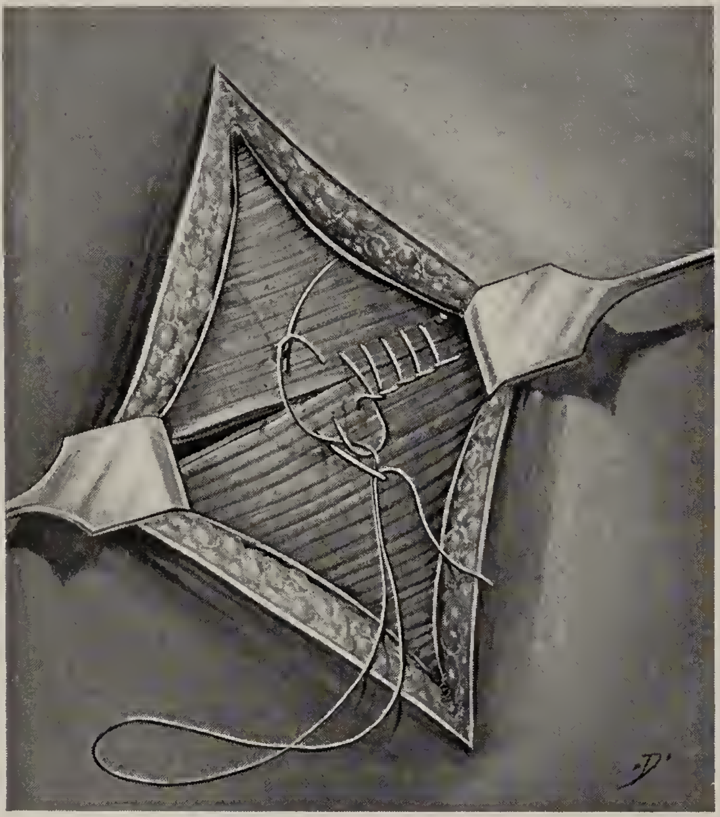

FIG. 472.—SUTURING THE TRANSVERSE INCISION IN MCBURNEY'S INTERMUSCULAR METHOD.

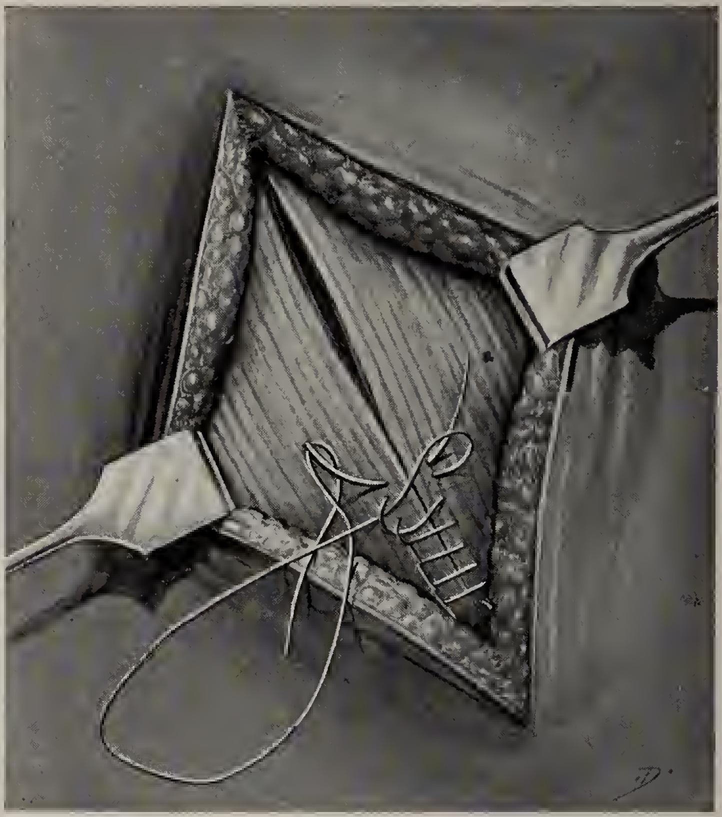

FIG. 473.—SUTURING THE INCISION IN THE APONEUROSIS OF THE EXTERNAL OBLIQUE IN MCBURNEY'S INTERMUSCULAR METHOD.

Marcy), or the chain stitch (Ford, Fig. 112). The silkworm-gut sutures are removed at the end of ten days by cutting them beneath the bolsters on one side, and making traction on the other ends.

The intermuscular incision is closed in separate layers by catgut continuous sutures, as shown in Figs. 472, 473, 474, and 475. In closing the incision in the aponeurosis of the external oblique, care should be taken to include both lamellae of the rectus sheath, as shown in the figure. The same remark applies to closure of the vertical incision. The skin incision is closed by a chain stitch suture of horse-hair. (For the After-treatment of Abdominal Section, see page 31.)

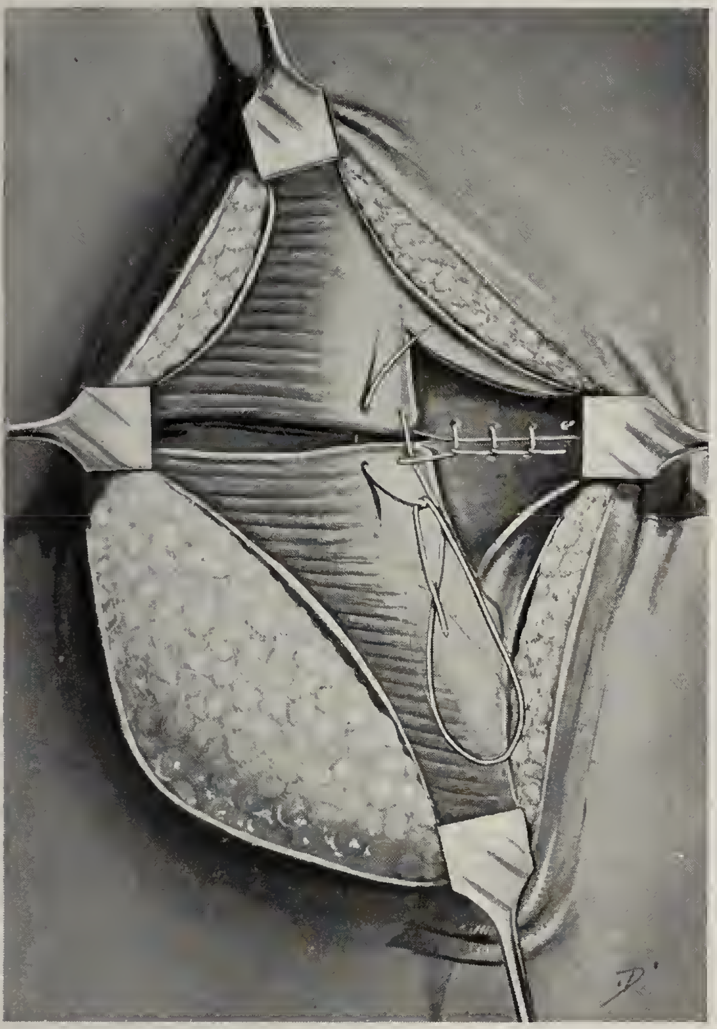

Fig 474.—Suturing the Transverse Incision in the Author's Intermuscular Method.

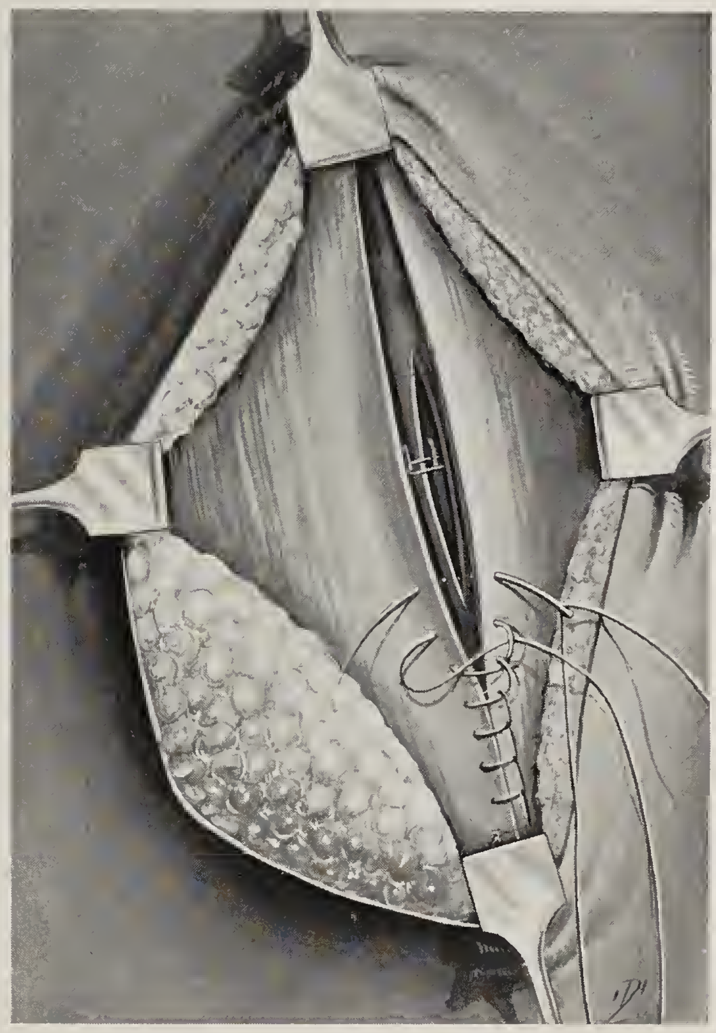

Fig. 475.—Suturing the Incision in the Aponeurosis of the External Oblique in the Author's Intermuscular Method.

Paratyphlitic abscess, or suppurative inflammation of the connective tissue about the cecum, without primary involvement of the appendix, is of very rare occurrence. It may originate in an abscess of the cecal wall from ulceration, or from perforation of the cecal wall by a foreign body. When occurring from ulceration this is preceded by endarteritis obliterans and thrombosis or embolism of the vessels. Figuera reported to the Brooklyn Surgical Society a case of a patient who developed a paratyphlitic abscess several months after the removal of the appendix for appendicitis. The operative treatment is the same as that for appendicular abscess.

THE RECTUM AND ANUS

Injuries of the Rectum and Anus by Foreign Bodies.—Swallowed foreign bodies, after passing through the intestinal canal, sometimes lodge above the internal sphincter of the anus, where they produce injury of the mucous membrane and may obstruct the passage of feces. They may be introduced from without, *e. g.*, in the case of would-be suicides, degenerates, lunatics, or criminals. Small foreign bodies are removed after dilatation of the anal opening. The hemorrhage which they sometimes occasion may require ligation of the bleeding vessels. If the source of this cannot be found, tight packing of the rectum should be resorted to. A colpeurynter may be introduced and distended with water. Or a chemise cannula may be improvised by tying a gauze bag about a piece of stout rubber tubing. After dilatation and introduction, gauze strips are packed in the bag. An opium suppository should precede the introduction; large coproliths made up of fecal matter, fat, and earthy salts have been removed from the rectum (Nussbaum). These may be removed with a rectal scoop or by the hooked finger. Injuries may result from the use of rigid enema tubes, giving rise to abrasions and consequent infection, which may extend to the perirectal connective tissue and cause suppuration. Wounds of various depths and size, as well as complete perforation, may occur from the same cause.

Ischiorectal disease may arise from injuries by foreign bodies, the latter having finally passed with the feces without being identified. The abrasion leads to infection of the submucous connective tissue, involvement of the muscular wall, and final infection of the connective tissue in the ischiorectal space. **Perirectal** and **perianal abscesses** of minor extent may arise in this manner, giving rise to troublesome fistulas (**fistula in ano**). The latter, however, are frequently of tuberculous origin (*vide infra*).

Injuries of the Peritoneal Portion of the Rectum.—Gunshot wounds in this region are rare. The majority of other injuries are due to penetration of the rectum by either puncture, or cutting instruments or objects, or long and blunt instruments, or foreign bodies. The sigmoid may be punctured by a stiff bougie, and the portion of the rectum covered by peritoneum may be ruptured by the examining hand of the surgeon, or by the Peterson balloon or colpeurynter used in distending the rectum in the operation of suprapubic cystotomy.

The **diagnosis** is to be made by the examining finger, the speculum, and the olive-tipped bougie. In employing the latter, care should be taken not to mistake a rent passing into the bladder for one involving the peritoneal cavity. In all doubtful cases a prompt exploratory laparotomy should be performed.

The **treatment** consists in the opening of the abdominal cavity, thorough cleansing of the pelvis, suture of the point of perforation or rupture, and the establishment of an artificial anus in the inguinal region. The deep pelvis should be drained by a glass tube. The artificial anus may be subsequently closed.

Examination of the Rectum.—The bowels having been emptied beforehand by the administration of a cathartic whenever possible, or by the use of an enema, the patient is placed in the left lateral semiprone position (Sims, Fig. 476) for digital examination, and in the knee-chest position for instrumental examination (Fig. 477). The buttocks are separated, the anal folds parted, and external inspection made first. The condition of the skin, the presence of fistulous openings, external hemorrhoids or other tumors or fissures, prolapse, etc., and the character of any discharge present should be noted.

Digital Examination.—Prior to a digital examination of the rectum the examining finger is covered by a rubber cot, or, in the absence of this, the nail portion is smeared with toilet soap. The finger is then lubricated with vaselin and introduced gently through the sphincter into the rectum, the patient making a slight bearing-down effort. Note should be made of roughened surfaces indicating ulceration, irregularities of the surface showing the presence of hemorrhoids, the position of the uterus in the female, and the presence of enlargement of the prostate in the male.

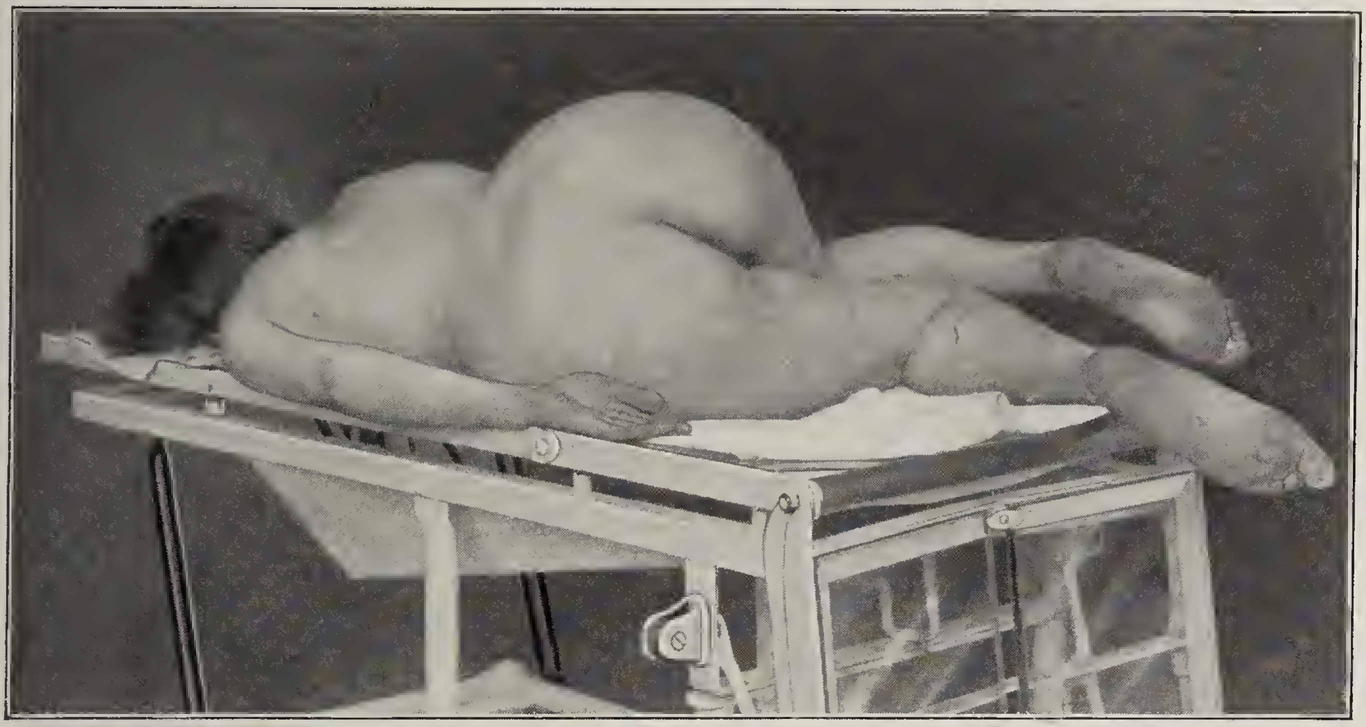

Fig. 476.—The Left Lateral Semiprone Position of Sims.

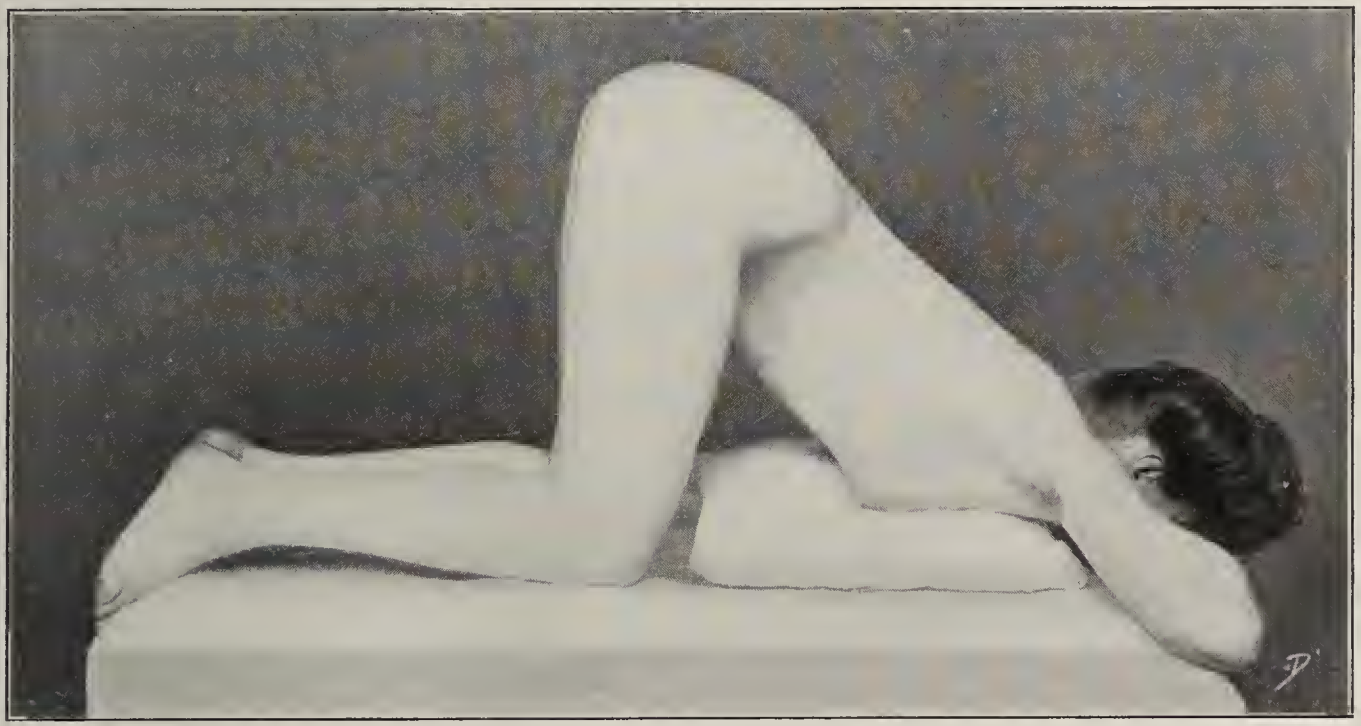

Fig. 477.—Knee-chest Position.

Visual inspection requires the use of a speculum (Figs. 478 and 479). With the patient in Sims's position only a limited field is afforded. For a more extensive view, the patient is placed in the genupectoral position and long, plain, tubular rectal specula are used (Kelly). Reflected light from an incandescent electric lamp or other source of light may be thrown into the tube by a head-band mirror on the examiner's forehead. Or, light may be carried directly to the parts by an electric light attached to a wire stem (Fig. 480). The tubular speculum is carefully introduced with the obturator in position; as the latter is withdrawn, air rushes in and the bowel is distended. The light is then introduced, when an excellent view of the mucous membrane is obtained. A tube sufficiently long to inspect the junction of the rectum with the sigmoid flexure may be used, if proper care is taken not to inflict damage on the rectal walls. An examination under ether with the patient in the genupectoral posture requires care on the part of both the anesthetist and the examiner, but it is entirely feasible.

The use of rectal probangs and the introduction of the entire hand into the rectum for purposes of examination are both dangerous and unnecessary.

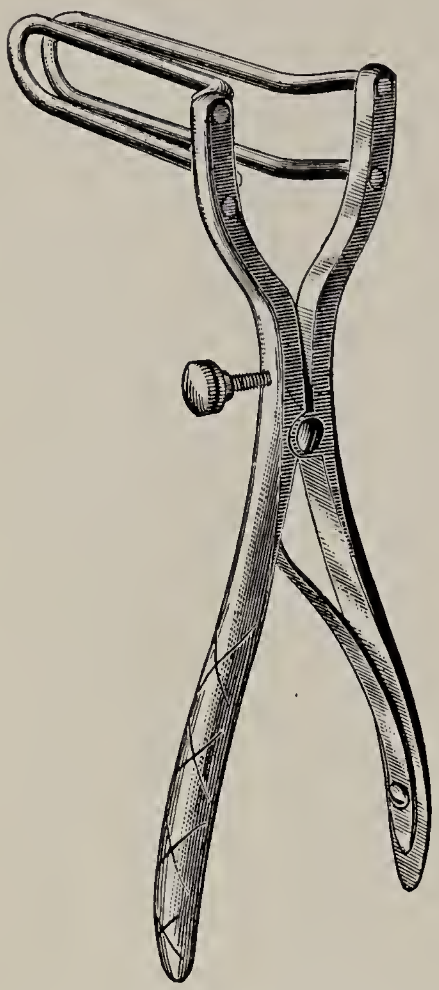

Fig. 478. — Sims's Rectal Speculum.

Inflammations of the Anus and Lower Portion of the Rectum.—Eczema and intertrigo, occurring in corpulent persons from friction in walking, are frequent affections. These, together with skin tabs, the remains of old external hemorrhoids, pin-worms and other sources of irritation frequently give rise to **pruritus ani.** More remote disturbances, such as nervous affections, excessive use of tobacco and alcohol, constipation, uterine and ovarian disease, etc., may also cause this. The itching is worse at night. The treatment consists in removal of the cause, frequent ablutions with hot water, and, after thorough drying, the application of a mixture of camphophenique and water, one dram to the ounce (Mathews). Kelsey recommends an ointment composed of menthol, dr. j; simple cerate, oz. ij; oil of sweet almonds, f. oz. j; carbolic acid, dr. j; powdered oxid of zinc, oz. ij. An ointment of chloroform, dr. j, and simple cerate, oz. j, is useful if applied frequently at night. In obstinate cases the parts may be touched with the **thermocautery,** and in otherwise intractable cases the **mucocutaneous margin may be excised.**

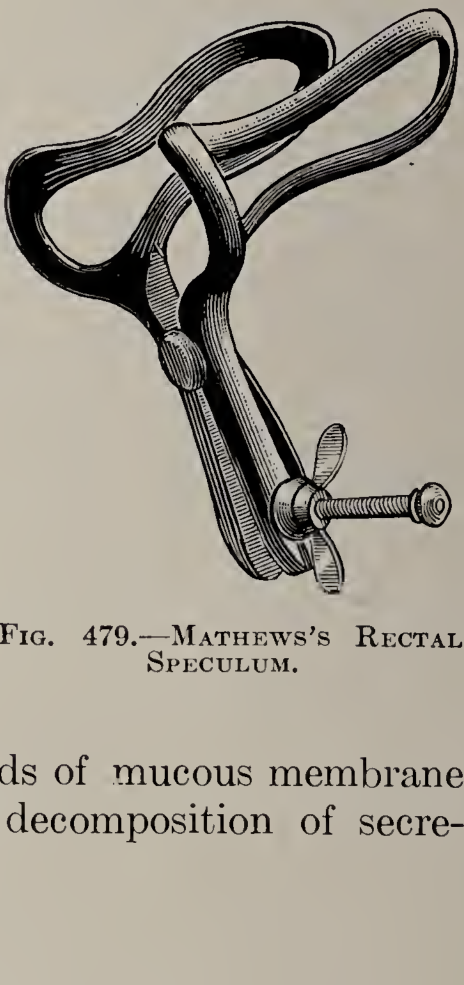

Fig. 479.—Mathews's Rectal Speculum.

Fissure of the anus arises in the radiating folds of mucous membrane at the anal opening. It is caused by arrest and decomposition of secretions and the presence of fecal matter. The excessive pains to which it gives rise are the result of dragging upon the margins by reflex contractions of the external sphincter; the pains persist for an hour or more after an evacuation. Fissures are most frequently found at the posterior aspect of the anal margin. Those of short duration may be touched with the solid stick of nitrate of silver. Old fissures can be treated successfully only by **dilatation of the sphincter** and **incision through the base of the ulcer** (Boyer).

Fistula in Ano.—This is the unhealed track of a discharging perianal or perirectal abscess, originating in infection from the rectum, and always commencing as such (**suppurative periproctitis**). The patient may be free from symptoms until the appearance of a small and tender prominence at the anal margin. If the pointing abscess opens or is incised before discharge into the rectum occurs, healing may follow. Usually, however, the pus passes in the direction of least resistance, *i. e.*, toward the rectal mucous membrane, and infection persists from communication with the cavity of the rectum, until finally an external opening also occurs. These abscesses may have a **tuberculous origin,** the lymphatic glands in the adipose tissue of the ischiorectal fossa becoming infected. These glands break down in cheesy matter and finally suppurate. Quite an extensive suppurative lymphadenitis may occur, which may lead to extensive phlegmon in this region. The dangers of general tuberculous infection from this source are considerable. The clinical appearances support the probability of tuberculous infection of the lymphatic glands in the perirectal tissues from the fact that, in the vast majority of cases, the fistulous tracts lead to the lateral aspect of the rectum where these glands are situated.

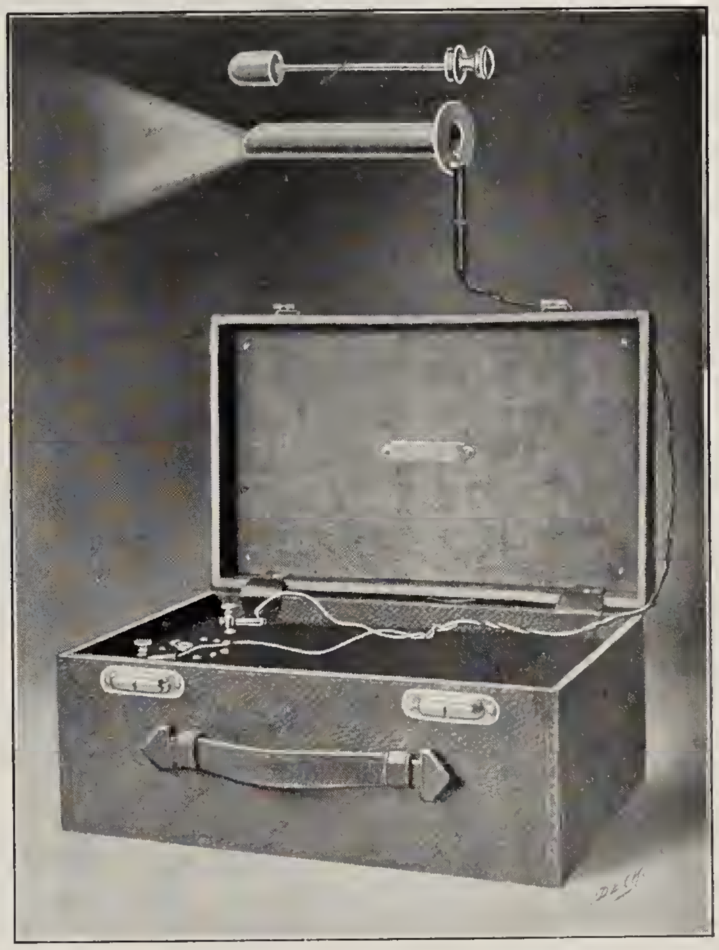
FIG 480.—TUBULAR RECTAL SPECULUM WITH ELECTRIC LIGHT.

In rare cases **suppurative periproctitis** may result from injuries and diseases of neighboring organs (bladder, urethra, vagina, uterus, pelvic bones, etc.). Abscesses which lie above the levator ani muscle, or between it and the rectum, spread in an upward direction by preference, while those below this muscle point toward the surface, the levator ani muscle forming a diaphragm at the pelvic outlet (Tillmanns).

In old cases of fistula in ano there may be a number of external openings with suppurating tracts partially encircling the anal margin (**horseshoe fistula,** Fig. 481). The opening into the rectum may close, leaving only a suppurating tract, which is "blind" internally but open externally (**external blind fistula,** Fig. 482, C), or the external opening may heal and the internal opening persist (**internal blind fistula,** Fig. 482, D). Finally, the entire track from the

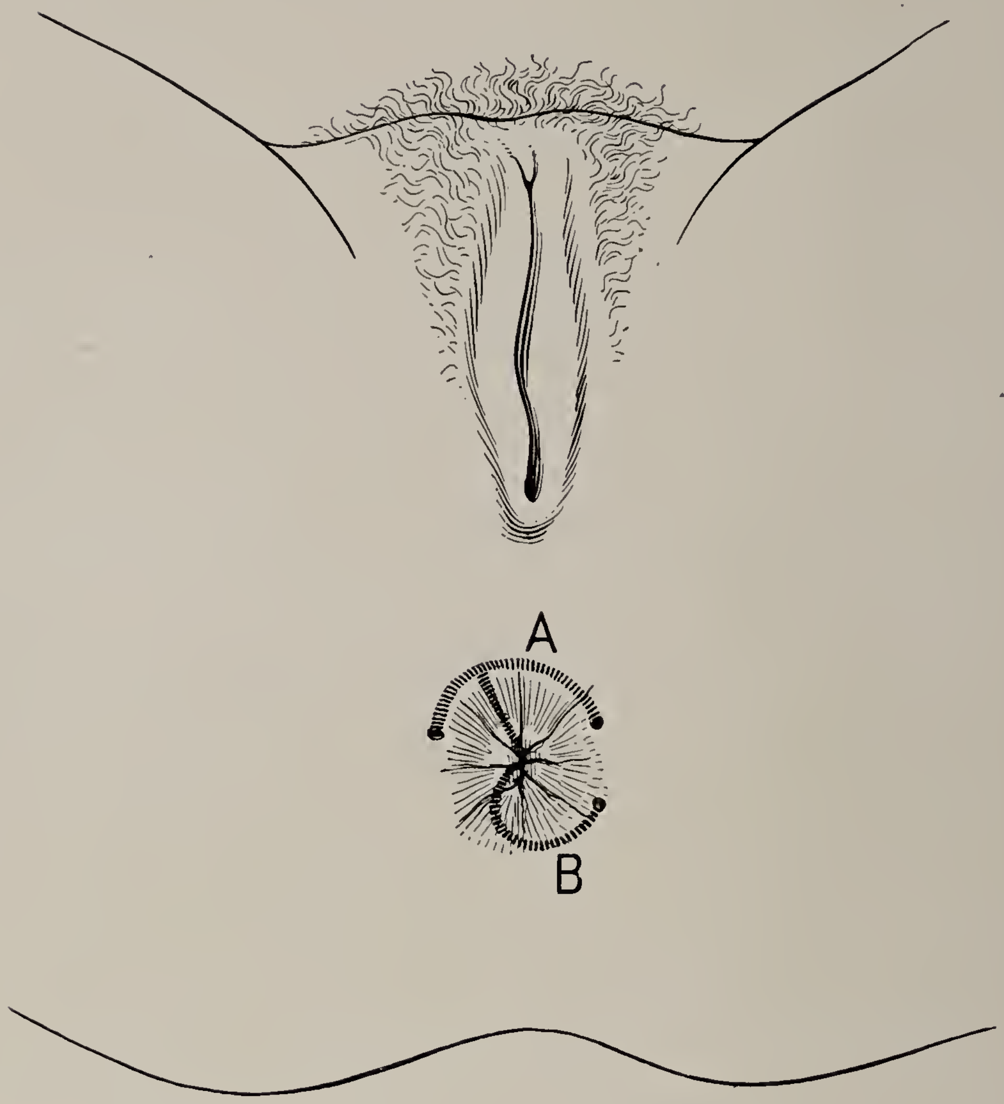

Fig. 481.—Horseshoe Fistula.
A, With two external openings; B, with one external opening.

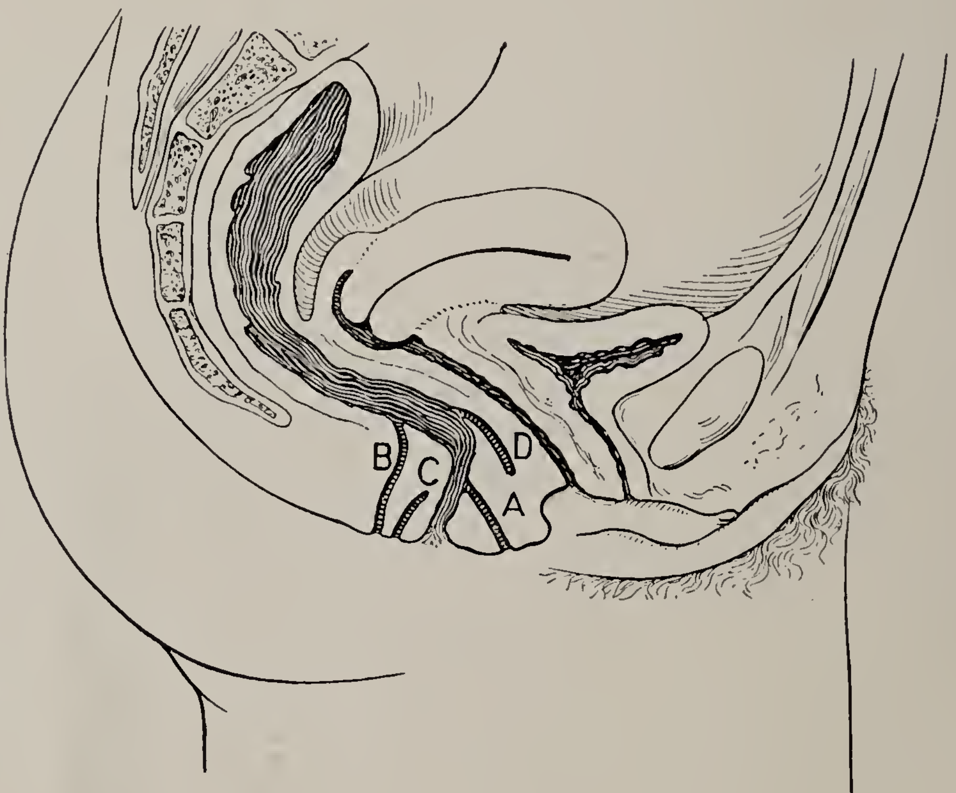

Fig. 482.—Fistula in Ano.
A, Complete fistula, low in rectum; B, complete fistula, high in rectum; C, external blind fistula; D, internal blind fistula.

internal to the external opening may persist (**complete fistula,** Fig. 482, A and B). When the original abscess is of anal origin, the internal opening lies between the two sphincters; in one following an ischiorectal abscess, the internal opening is in the rectum at varying heights. There may be burrowing of pus outside the rectum for a considerable distance above the opening. Fresh infection occurs and new abscesses are liable to form. Pain on and after defecation is complained of and offensive pus and fecal matter escape from the external opening. The latter is absent in cases in which the fistula is not complete. In internal blind fistula the symptoms are pain on defecation, local uneasiness and pain when fecal matter enters the internal opening, and occasional discharge of blood from the anus. In examining for fistula in ano a slender flexible probe should be used. It is more than probable that many of the cases of external blind fistula really have a communication with the rectum.

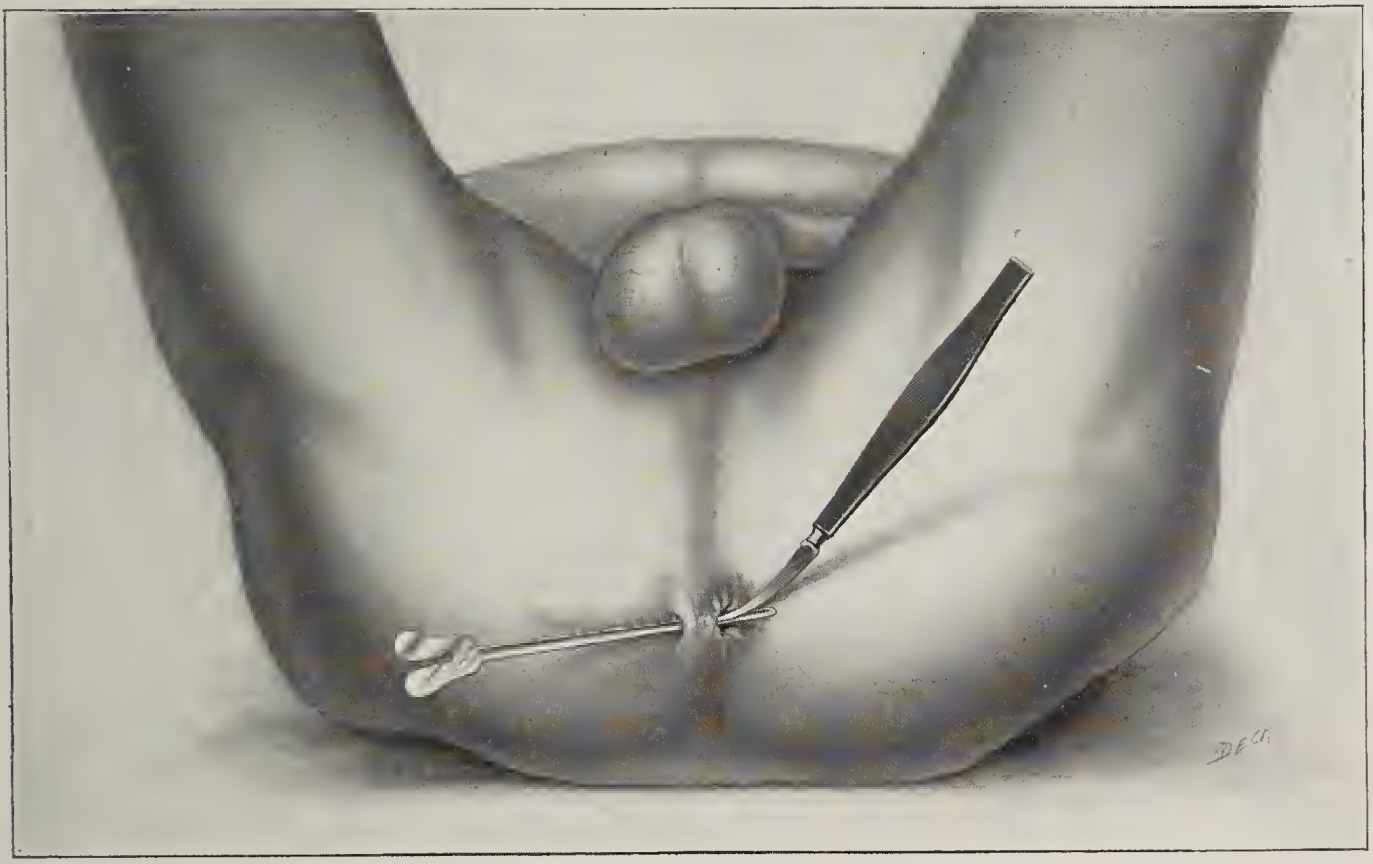

FIG. 483.—OPERATION FOR FISTULA IN ANO.

The **differential diagnosis** should exclude openings of urinary fistulas and those arising from carcinoma. Internal blind fistula must be differentiated from gonorrheal and catarrhal proctitis.

The **treatment** of fistula in ano is always operative. This consists in passing a grooved director along the fistulous track to its termination in the rectum, with the finger in the rectum as a guide. If the opening in the rectum is not easily found, and the intervening tissues are very thin, one should be made at the thinnest point between the grooved director and the finger. The end of the grooved director should now be brought out of the bowel and the intervening tissues forced downward on it and divided (Fig. 483). If two or more fistulas exist, these will almost always be found to communicate with the rectum by one route. Each should be opened up separately, but under no circumstances should the sphincter be divided in more than one place at the same sitting. If two separate fistulas enter the rectum, the one must be allowed to heal before the sphincter is divided again at another point. If thick intervening tissues are present between the termination of an external blind fistula and the rectal wall, the external parts should be freely incised, all cicatricial and diseased tissues cut away, the curet freely applied to the depths, and the cavity packed with zinc oxid gauze wet with hydrogen dioxid, followed in a day or two by Peruvian balsam gauze. In the case of an internal blind fistula, this must be converted into a complete fistula and treated as such. Zinc oxid gauze wet with hydrogen dioxid, followed in a few days by Peruvian balsam gauze, which is held in place by a T-bandage, moving the bowels after forty-eight hours, change of dressings daily and more frequently if they become soiled with feces, irrigation with Thiersch's borosalicylic solution at each dressing, and the endeavor to get the patient out of bed as soon as possible, cover the main points in the after-treatment.

The **elastic ligature** causes strangulation of the included structures, cutting its way out in a week or less. It cannot be relied on to cure, failure always occurring in the cases in which burrowing or secondary fistulous tracks or channels are present. It is to be resorted to only when operation by the knife is refused, in cases of deep fistula where hemorrhage is to be feared, and in patients with the hemorrhagic diathesis. The ligature consists of a solid rubber cord $\frac{1}{10}$ of an inch in diameter. It is passed with the aid of a probe with an eye at the end, the ligature entering at the external orifice and emerging at the anus. The ends of the cord are passed through a small lead plate with two holes in it, the ligature drawn as tightly as possible, and secured by tying with a thread or by clamping. The pain, which is severe during the first twelve hours, may be controlled by opium suppositories.

The Question of Operating for Fistula in Ano in Phthisic Subjects.—If tuberculous infection of the lungs has already occurred and is only incipient, or, if it is advanced to cough and expectoration and the fistula is accompanied with profuse discharge, the operation should be performed. In the case of a patient who is in an advanced stage of phthisis, with considerable cough, and a fistula that is practically stationary and has a slight discharge, as well as in the case of one who is in the last stage of phthisis, the operation should not be performed.

Prolapse of the Anus and Rectum.—Simple prolapse of the mucous membrane at the anal orifice is called **prolapsus ani,** while descent of the entire circumference and thickness of the rectal wall constitutes **prolapsus recti, or procidentia recti.** The chief predisposing cause is a relaxed condition of the muscular and connective-tissue structures of the bowel. The latter alone may be involved primarily. A relaxation of the muscular tissues, in addition, leads to a protrusion of both the entire thickness and the circumference of the rectum, and it is only a question of time, after this stage has been reached, when the peritoneal covering of the bowel will have also descended sufficiently to protrude through the anus. The sphincter ani and the levator ani muscles become involved in the pathologic process, and the loss of support which this entails still further increases the tendency to prolapse and protrusion of the superimposed bowel. Even in the early stage of these conditions, the finger introduced into the rectum does not, as a rule, meet with the normal resistance. Finally, an abnormally long mesorectum has been suggested as a possible predisposing cause (Allingham).

The lower portion of the rectum is more markedly muscular than that which lies immediately above, the latter being wider and laxer. This again merges into a portion above which is supplied with stronger muscular circular fibers. This last mentioned portion, through contraction of its muscular fibers, is capable of inverting and pushing the middle lax portion down to the anus, from which it finally protrudes (Henoch).

The principal **exciting causes** during childhood, at which period of life these symptoms are most likely to occur, are constipation, as well as diarrheal and dysenteric affections, the presence of a rectal polypus and certain forms of ascarides, all of which produce more or less rectal tenesmus. Phimosis, by offering obstruction to the free flow of urine, may serve as an exciting cause. In adults, vesical tenesmus incident to the presence of an enlarged prostate, stricture of the urethra, or a vesical calculus, are exciting causes. Hemorrhoids, and in females prolapse of the uterus, may complicate the prolapse in adults. Finally, cases occur in which no well-defined exciting cause can be determined.

The first onset of the prolapse may be sudden, in which case it is due to some excessive straining effort. More frequently, however, the onset is gradual, the mucous membrane becoming at first prolapsed; procidentia and finally invagination occur as later stages of the condition. In simple prolapse the protruding mucous membrane appears as bright red folds, between which sulci radiate from the aperture. This is due to the fact that the entire circumference of the bowel is not involved, the principal masses being placed laterally. In procidentia the tumor is much larger, and the sulci are arranged in a direction parallel to the anal margin. The protrusion in the beginning is small, occurs only after defecation, and is easily replaced and retained until another act of defecation forces it out again. Later on it reappears in the interval, and, owing to inflammatory infiltration of the mucous membrane and submucosa, and the resistance offered by the sphincter, complete replacement is not always easily accomplished. With further weakening of the muscular apparatus the mass is more easily returned than it is retained. Abrasion of the mucous membrane, from which bleeding may occur, results from friction of the clothing; trophic disturbances may lead to ulceration. In addition, both a mucopurulent discharge and bleeding from the anus may occur without constant protrusion of the mucous surfaces. In advanced cases constipation and diarrhea alternate. Fecal incontinence may be present. More or less pelvic distress is complained of, and in some cases there is pain in the loins and thighs. In males the dragging upon the bladder and urethra may produce difficulty in micturition.

The **diagnosis** is made by an inspection of the parts. While the protrusion of internal hemorrhoids is usually associated with more or less prolapse of the mucous membrane covering the sphincters, and in some instances of that which lies immediately above, this condition can be easily differentiated from true prolapse of the rectum. The presence of hemorrhoidal tumors, with their livid color, as well as an increased firmness of the mucous membrane, is characteristic of this condition. In the case of a child, a polypus may complicate the diagnosis. This, however, may be usually isolated, and its attachment identified. In incomplete or partial prolapse, and before the occurrence of complete relaxation of the sphincters, vascular stasis of an imprisoned portion of the mucous membrane of the bowel may result from efforts at contraction of the irritated muscles, and sloughing of the parts follow. On the other hand, relaxation of the sphincter to the stage of complete insufficiency may precede the occurrence of the gangrene, in which case the latter is to be attributed to trophic nerve disturbance, or inflammatory stagnation (endarteritis obliterans). This process of circular sloughing constitutes one of nature's efforts to cure.

In cases in which the peritoneal covering of the gut is involved, the latter may become the seat of inflammatory changes, which are followed by obliteration of the peritoneal pouch. In the milder forms of prolapse this adhesive inflammation does not occur, and the protruded portion of the peritoneum retains its relations with the general peritoneal cavity. The pouch of peritoneum may be the sac of a hernia and contain portions of small intestine, an ovary, and exceptionally the bladder. Even other viscera have been found similarly involved. The intestine may become strangulated in the sac, and an "anus preternaturalis in ano" result (Esmarch). Spontaneous rupture of the rectum without preceding ulceration (Quénu) may occur as a complication.

Treatment.—The use of tonics, and, in the case of adults, changes in the habits and occupation of the patient, are indicated. The diet must be regulated and constipation avoided. Moving the bowels with the patient lying on the side and one buttock drawn aside to make the anal opening tense will sometimes prevent the occurrence of the prolapse (Maylard). When the affection is due to any of the remediable exciting causes mentioned, such as the presence of a contracted prepuce, rectal polypus, parasites, stone in the bladder, or any condition of the urinary outlet producing straining efforts, these must be first removed before a cure can be brought about. Reduction may usually be accomplished by the patient himself, if an adult. If the surgeon is called in, with the patient in the knee-elbow position he may proceed by spreading a round piece of dry lint or coarse table linen over the protruding mass, and, after oiling his finger to facilitate its subsequent withdrawal, push the mass, linen and all, into the rectal cavity. Or the finger lubricated with vaselin may be introduced into the rectum and reduction effected by taxis around the finger (Mathews). The previous application of cold and the inversion of the patient facilitate reduction. A pad and T-bandage should be worn. In children the buttocks may be strapped together.

Linear cauterization (Van Buren) is performed as follows: After the bowels have been thoroughly emptied, an anesthetic is administered. The mucous membrane is lightly touched in narrow longitudinal strips with the cautery, after which the mass is reduced. The bowels are kept confined two or three days by means of opium in small doses and the first movement preceded by a liberal enema of sweet oil. Allingham cleanses the protruding mucous membrane and applies nitric acid. The patient is kept in the recumbent position for from four to six weeks and no bowel movements are permitted to take place except when he is in this position.

Temporary narrowing of the anal aperture by means of a pursestring suture (Pratt, of Johns Hopkins Hospital), while of itself not sufficient to cure an advanced prolapse, may be useful in the mildest cases, as well as supplementary to Van Buren's and Allingham's methods and certain methods of fixation. A curved needle is introduced at the junction of the skin and mucous membrane, just beneath the latter and in the median line posteriorly, and a silk thread carried half-way around the anus and out again in the median line in front. It is reinserted in the opening of exit and brought out at the point of original puncture, the anus being thus completely encircled. The little finger of an assistant is passed into the rectum and the pursestring suture tied on it. I have used this method successfully, substituting kangaroo tendon for silk, as an adjunct to linear cauterization and rectal suspension.

Excision of portions of the rectal mucous membrane has succeeded in certain mild cases. The excised portions are lozenge-shaped and so arranged that the resulting eschars are longitudinally placed. Two or more of such elliptic excisions may be applied, according to the size of the prolapse. In more advanced cases it will also be necessary to narrow the external orifice by the application of the pursestring suture. The removal of portions of the mucous membrane by means of the clamp and cautery has been effected (Henry Smith).

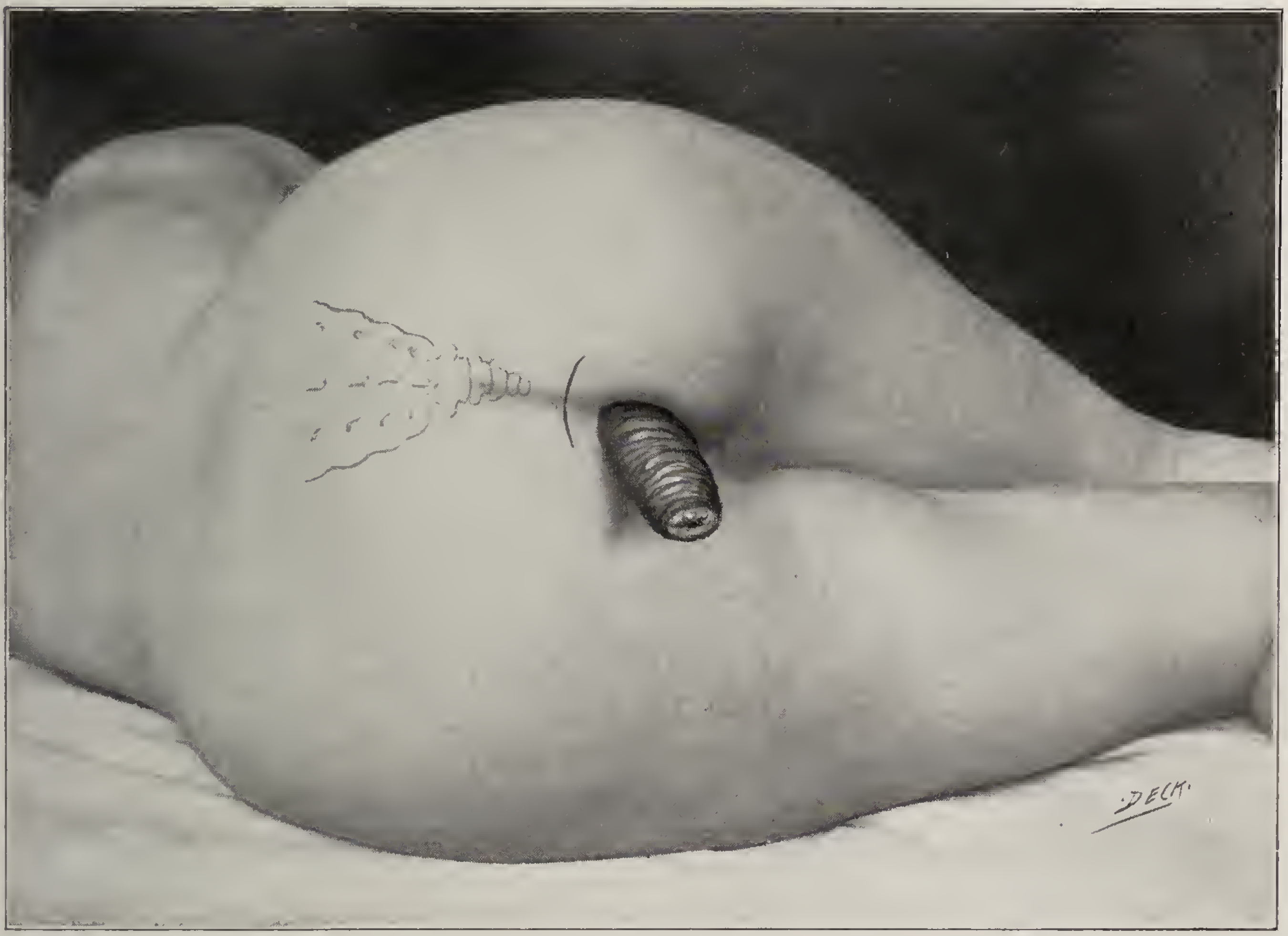

Fig. 484.—The Author's Operation for Prolapse of the Rectum. The Semicircular Incision.

Elevation and fixation (proctopexy) are designed to suspend and secure the prolapsed portion in position, the space between the rectum and the coccyx being utilized by Verneuil for this purpose. My own method is as follows: A curved incision is made half-way between the anal margin and the point of the coccyx (Fig. 484). The dissection is carried well up between the rectum and the sacrum. With two fingers in the rectum the posterior wall of the latter is forced through the external wound and four sutures of heavy kangaroo tendon or chromicized catgut passed through the rectal wall on the lateral and posterior aspects of the gut. The sutures are placed so as to include all the tissues of the rectal wall to the mucous membrane (Fig. 485). An incision is then made, which is commenced at the junction of the sacrum and coccyx and carried to the end of the latter. The ends of the sutures are now brought out on each side of the coccyx, the prolapse reduced, and the sutures tied across the bone, traction being made to bring the rectum into position. The incisions are now closed.

In cases in which there is a decided dilatation above the sphincter, three or four sutures are placed in the presenting rectal wall in Lembert suture fashion, before reduction, and tied so as to produce an infolding effect, thus rendering more solid this portion of the bowel wall. If the anal orifice is markedly relaxed, Pratt's pursestring suture may be added (*vide supra*).

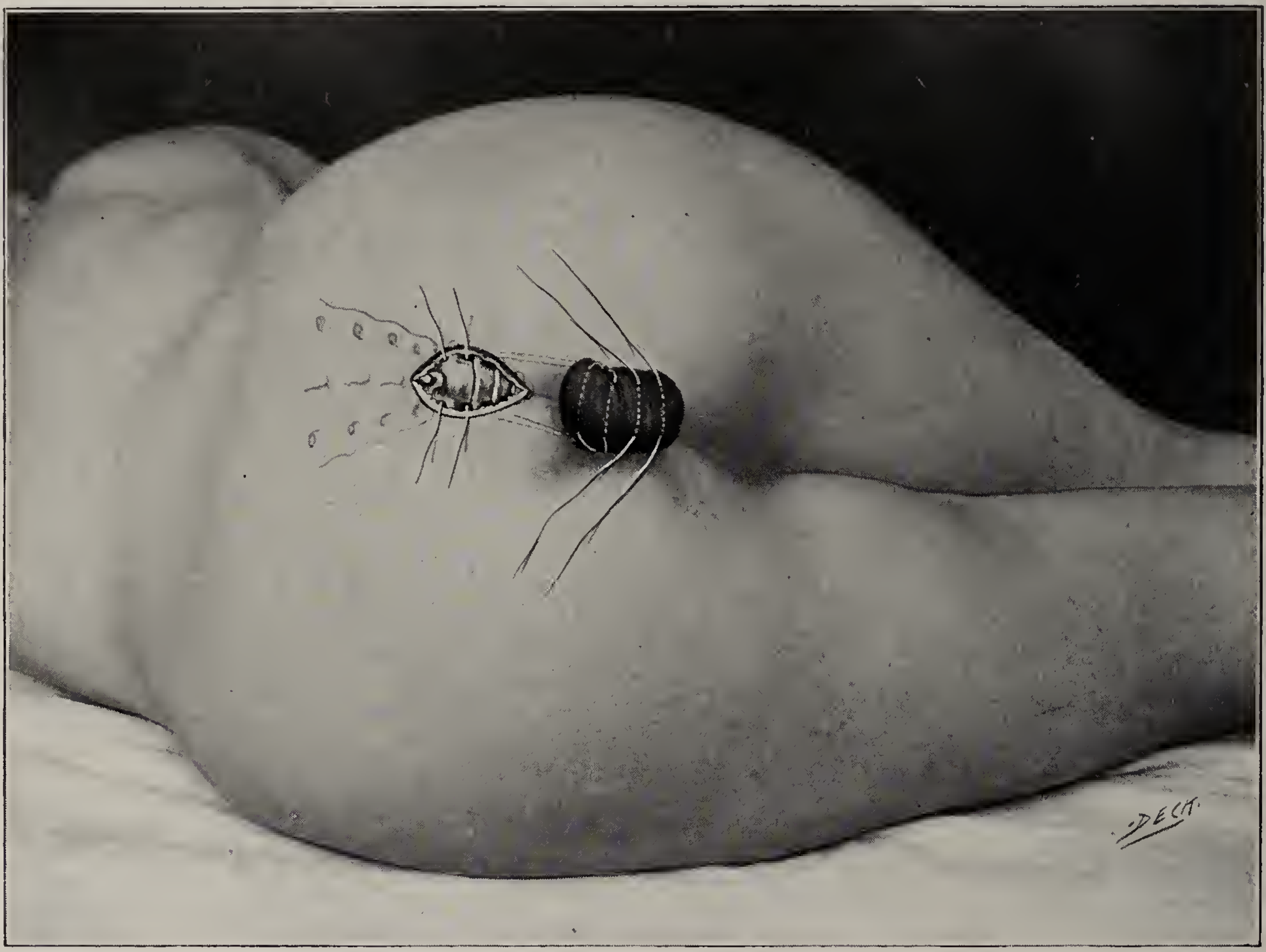

Fig. 485.—The Author's Operation for Prolapse of the Rectum.
The rectum is forced through the incision and the sutures applied. The two upper sutures have been passed to both sides of the coccyx, which has been exposed by a vertical incision for the purpose.

A still higher fixation may be obtained, when necessary, by passing the sutures to each side of the sacrum (Tuttle).

Colopexy.—Bryant, of New York, advocates entering the peritoneal cavity through a three-inch incision parallel to Poupart's ligament and one inch above it. The peritoneum is well separated and the prolapse reduced by pulling the gut firmly upward. It is then secured to the loosened peritoneum by quilting sutures which include the muscular coat of the bowel. Supporting sutures are added to include the entire thickness of the abdominal wall and the muscular coat of the bowel behind the longitudinal band. These latter sutures serve also to close the external wound. The principal objection to this operation is the danger of a hernial protrusion due to the interposition of intestine between the wound edges; this occurred in one of Bryant's cases. To obviate this danger I have devised a method in which the intestine is supported by four strips of peritoneum cut from the edge of the peritoneal incision. The two cut from the one side are left attached toward the extremities of the incision, while the two cut from the other side are left attached toward the center. The peritoneal strips are detached, passed through slits in the serous and muscular coats of the large intestine, and secured by sutures to the parietal peritoneum (Fig. 487). The wound is then closed in the usual way.

Amputation of the Rectum.—Operations designed for the removal or amputation of the protruding mass of bowel may be performed aseptically, and a strict regard for this part of the operative technic should always be observed. All operations of this character should be preceded by a few days' purgation with salines, during which time the patient should be fed with sterilized liquid food. In amputation of the rectum both the cavity of the bowel and the peritoneum are invaded, and increased caution is necessary in the manipulation lest the peritoneal cavity be soiled by infectious material. The protruding portion of gut should be well washed with soap and warm water before the incisions are made, the parts being protruded by the patient for that purpose before anesthetization; during the operation the parts are to be constantly irrigated with the borosalicylic solution of Thiersch. The best position for operating is the lithotomy position, and in order to secure gravitation of the abdominal contents away from the seat of operation, the pelvis should be well elevated. All bleeding points are secured, the sutured parts are returned, and an opium and iodoform suppository is introduced.

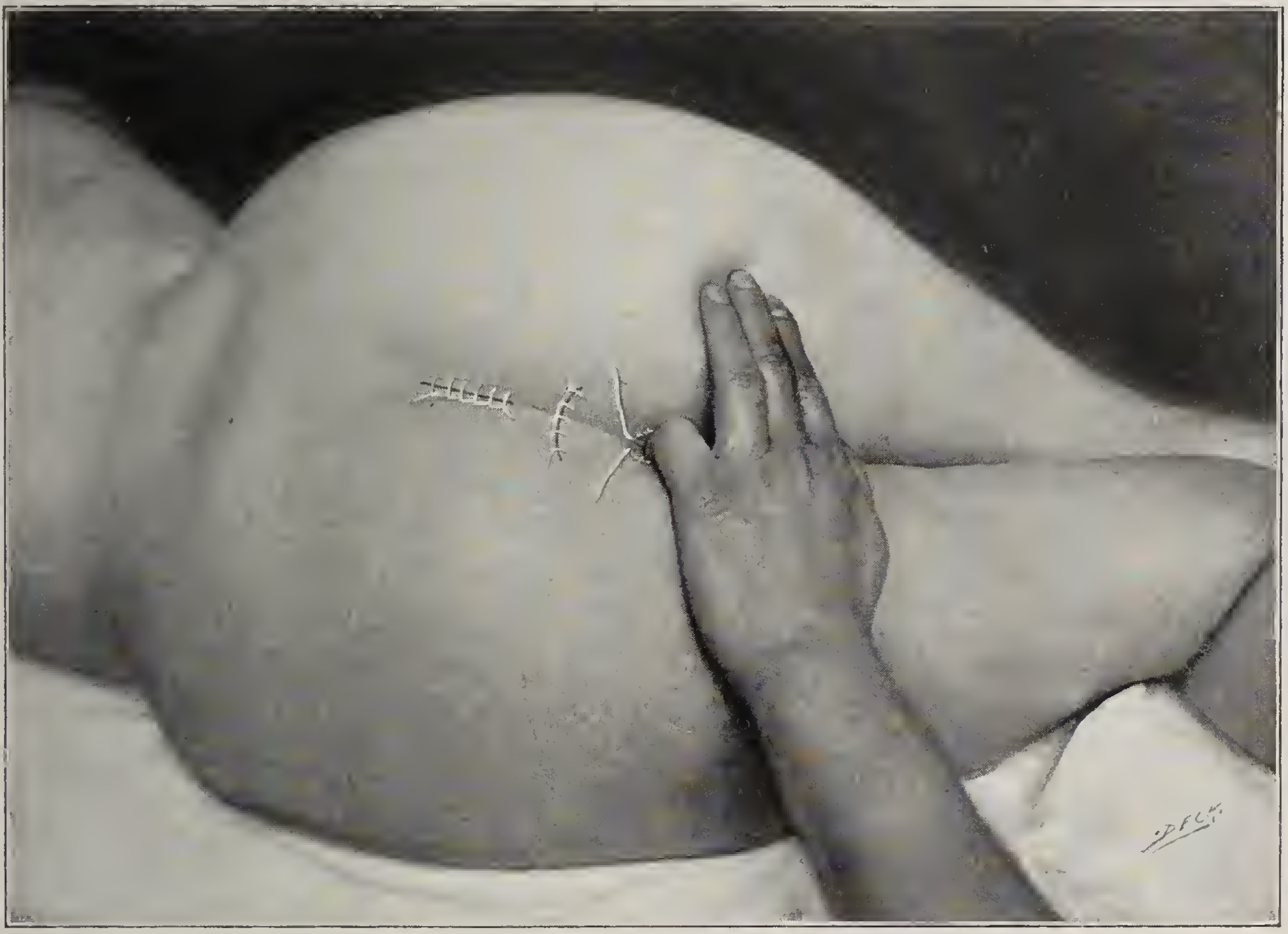

Fig. 486.—The Author's Operation for Prolapse of the Rectum.
The incisions closed and the pursestring suture ready for tying. The finger is passed into the rectum before tying the pursestring suture, in order to guard against complete occlusion.

My own technic is as follows: The patient is placed in the combined lithotomy and Trendelenburg position. A row of light artery forceps is placed just below the mucocutaneous junction in such a manner as to pinch up a fold of the mucous membrane of the outer cylinder the entire circumference of the gut. A circular incision is made about an inch in front of the row of forceps, including only the mucous membrane, the proximal edge of which is dissected back for an inch. The row of forceps is now transferred to the edge of the mucous membrane flap or cuff, and this is held up and out of the way by an assistant. Two additional clamps are now placed, one on each side, at the point of the prolapse, or the place where the outer cylinder of the gut returns to form the inner cylinder. With the mass thus steadied and the two cylinders identified, the index-finger of the left hand is passed up the inner cylinder, and with this as a guide and the cuff of mucous membrane held out of the way, a half-inch transverse incision is made so as to include the remainder of the thickness of the outer cylinder and the entire thickness of the inner cylinder. A suture of chromicized catgut is now placed so as to include the entire thickness of the two cylinders at the site of the half-inch opening, with the exception of the turned-back mucous membrane cuff at the anal mucocutaneous margin held

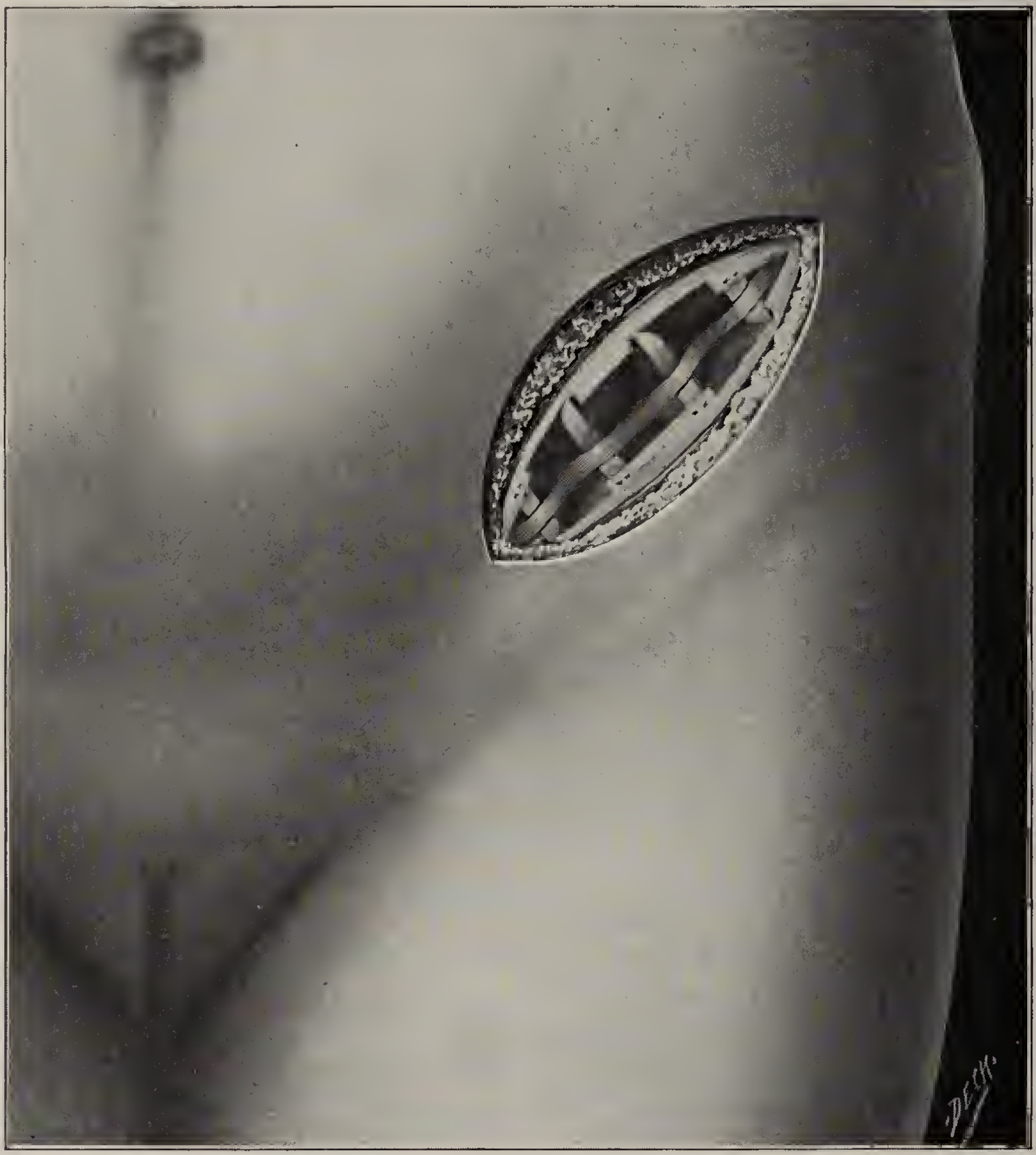

Fig. 487.—Author's Method of Colopexy.

Peritoneal flaps are cut from the peritoneal edges of the wound. These flaps are left attached at one extremity, and are passed beneath the longitudinal band of the colon and secured by sutures to the peritoneal edges opposite.

in the grasp of the forceps. This step of the operation is repeated until the entire circumference of the cylinders is traversed, except that each subsequent suture is applied first and the incision extended afterward. Care is to be taken that each extension of the incision is carried no farther than the area previously secured by the suture. Throughout this portion of the operation a stream of warm borosalicylic solution (Thiersch's) is to be kept playing on the parts. In a large prolapse the mesenteric portion of the gut is encountered when the posterior portion of the circumference is reached. This is treated precisely as the anterior portion, the vessels of the mesentery being secured by the suture. As the last suture is applied the final cut is made in front of it, completing the amputation of the prolapse. The cuff of mucous membrane previously dissected back is now brought down and sutured in position over the first row of sutures. Catgut is to be used throughout. An opium suppository is placed high up in the bowel and the parts replaced. A light tampon of gauze is placed in position for forty-eight hours, after which it is removed and a castor oil cathartic given, followed in three hours by a sweet oil enema.

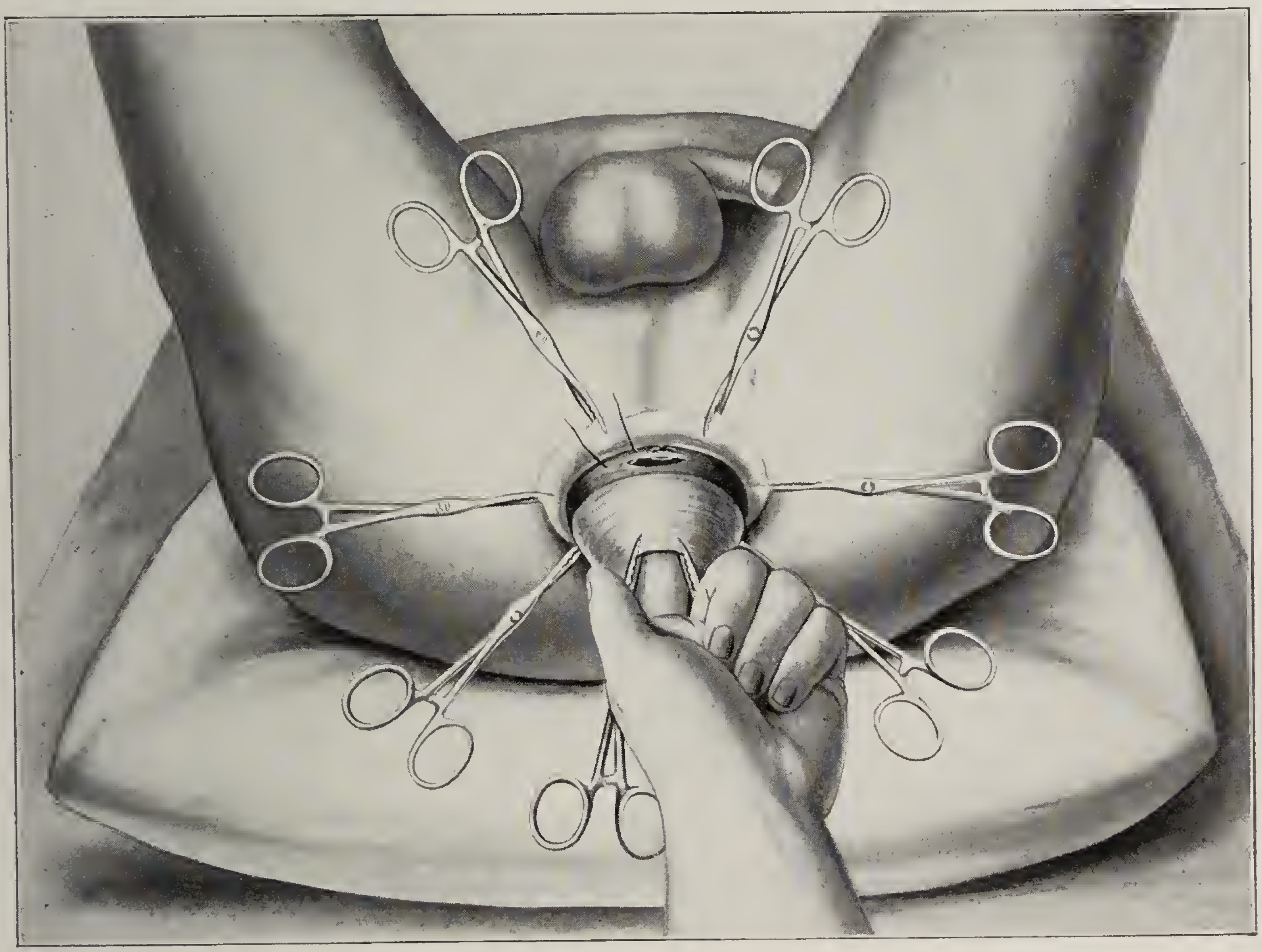

Fig. 488.—The Author's Operation for Amputation of the Rectum.

A cuff of mucous membrane has been turned back and grasped by forceps. Both cylinders are secured at the apex of the prolapse by forceps. The finger is introduced into the rectum as a guide upon which the incision through both cylinders is made A suture is shown in position preliminary to further extension of the amputating incision.

The special features of this operation are the following: (1) the use of the combined lithotomy and Trendelenburg positions, this preventing the descent of the small intestines during the operation; (2) the turning back of a cuff of mucous membrane for the purpose of preserving the normal conditions at the rectal outlet, and at the same time permitting the removal of all the relaxed and overstretched mucous and submucous structures at this point, the cuff itself providing a covering for the sutured edges of the stump of the prolapse and diminishing opportunities for subsequent infection; (3) the application of the suture first, and then an extension of the incision through both cylinders to correspond with the sutured area, in order to avoid the exposure of the peritoneal cavity to infection (Fig. 488).

In **Mikulicz's operation** the intestine is fixed by two strong sutures passed through the most dependent part of the protrusion and a transverse incision made in the anterior face of the portion of the gut which presents itself, or that portion which lies externally. This incision is made from 1 to 2 cm. in front of the supposed site of the anal opening. When the external portion of the intestinal tube is completely cut through, the peritoneal pouch between the two portions of the gut is opened and the peritoneal covering of the internal intestinal tube exposed. The communication with the peritoneal cavity is shut off by suturing the peritoneal surfaces together as fast as the transverse incision is extended, the surgeon extending the latter and placing catgut sutures in position as he proceeds, until the entire circumference and thickness of the external portion of the intestinal tube is divided. The internal intestinal tube is now divided just in front of the row of sutures already applied, and the two extremities of the gut united by a second row of sutures which includes all the coats of the intestine. Mikulicz employs silk for this second row of sutures and leaves them long. Chromicized catgut may be employed with advantage, and the difficulties of finally removing the sutures avoided. In order to prevent the line of union from slipping away from the operator during this portion of the manipulation, the stumps may be grasped with several pairs of fixation forceps. Finally, the line of sutures is to be dusted with iodoform and the remainder of the gut replaced.

Ulcers of the Anus and Rectum.—Soft chancres occur about the anus as the result of infection from chancroids of the vulva or the vagina, from direct transmission of infection from the male organ (sodomy), or from the finger; they may become phagedenic. **Primary syphilitic chancre** may also occur from sodomy. Secondary and tertiary syphilitic affections occur in the shape of condylomas, gummatous infiltration, and broken-down gummas. **Stricture of the rectum** may follow (see page 127). **Tuberculous ulceration** of the anus and rectum may result in abscesses and fistulas. A single large ulcer may extend to the neighboring skin and resemble epithelial carcinoma. The **prognosis** of tuberculous ulcers is grave; progressive destruction of the involved parts is the rule. **Simple ulcer** of the rectum is usually traumatic and arises from abrasions from fecal masses, a foreign body, an operation for hemorrhoids, and protracted labor. It is usually single, with flattened soft edges. **Follicular ulceration** results from chronic catarrhal inflammation due to gonorrheal infection and other causes. These ulcers are small, multiple at first, sometimes forming large and extensive ulcers by coalescence. **Dysenteric ulcer** is usually situated at the upper part of the rectum and sometimes leads to suppurative periproctitis, or even peritonitis.

The symptoms of ulcer of the rectum are as follows: (1) discomfort, or even considerable pain and tenesmus in defecation; (2) discharge of mucus and pus, varying with the extent of the ulceration; (3) diarrhea. When the ulcer is situated near the sphincter, painful spasm of the latter may occur (**sphinc-**

terismus). All pronounced ulcers in this region, excluding those of traumatic origin, should be regarded as either syphilitic, tuberculous, or gonorrheal.

Treatment.—In simple ulcer the bowels are to be kept loose with salines, the rectum washed out after every defecation, and the ulcer touched occasionally with pure carbolic acid, or with a 40 grain to the ounce solution of nitrate of silver through the speculum. This is to be followed by dusting the ulcer with aristol, subgallate of bismuth, or iodoform. In persistent cases the sphincters are to be stretched, the base of the ulcer incised, and the edges touched with fuming nitric acid. Soft chancres, gonorrheal ulcers, and primary syphilitic ulcers are treated locally like those on the external genitals. All affections of syphilitic origin are to be treated by antisyphilitic remedies. In tuberculous ulcer the local treatment must be promptly applied; it includes excision of the ulcer, the application of the thermocautery, the use of iodoform (insufflation, or iodoform emulsion), etc. Every effort to improve the patient's general health must be made. Dysenteric ulcer is best treated by injections of hot water and the application of pure carbolic acid or solutions of nitrate of silver. Finally, in the intractable cases of ulceration of the rectum it may be necessary to give the parts rest by performing an inguinal colostomy (see page 135) and at the same time providing for efficient irrigation.

Strictures of the Rectum.—These are divided into (1) congenital strictures; (2) those arising from cicatricial contraction; (3) strictures due to tumors of the rectum.

Congenital strictures have their origin in malformations of the mucous membrane. Many of them are due to incomplete atresia of the rectum (see Imperforate Anus, page 128). They may be the cause of prolapse of the rectum. **Cicatricial strictures** result from injuries and from ulceration, following inflammations of various kinds that involve destruction of the bowel wall (syphilis, etc.). Simple stricture is usually situated within two inches of the anus. Diffuse induration and contraction may follow chronic catarrhal inflammation. (For tumors of the rectum, see pages 130 and 135.)

The **symptoms** of stricture of the rectum are difficulty of defecation, and, when the stricture is low down, diminished size of the stools, which may be flattened and narrow, pipestem-shaped, or may occur in small lumps. There is passage of mucus and, in advanced cases with ulceration, the presence of blood in the stools. The stenosis may finally amount to complete obstruction. Even prior to this, there may be attacks of colicky pains and distended abdomen. Examination with the finger may disclose the stricture at once, if this is low down. Examination with the rectal bougie is unsatisfactory. The introduction of Kelly's long rectal speculum with the patient in the genupectoral position may assist in the diagnosis. Examination with the whole hand is not justifiable. In a case coming under my care at St. Mary's Hospital, an attempt had been made to make a diagnosis in this manner; rupture of the peritoneal portion of the rectum and fatal peritonitis resulted.

Treatment.—When **not due to cancer of the rectum,** the stricture may be subjected to gradual dilatation. This may be done by rectal bougies (Fig. 489), the size of these being increased from time to time. Great care must be employed in the use of these, the smallest size that will enter being used at first. The bowels should be kept free during the treatment and the bougie should be passed every other day. After complete dilatation is accomplished the patient should pass the instrument from time to time to prevent recontraction. Strictures not amenable to this treatment (hard, fibrous strictures), if not too long, should be incised superficially in the posterior raphe and dilatation continued. If the stenosis is extreme and otherwise intractable, the stricture may be excised (see Resection or Extirpation of the Rectum, page 131), or inguinal colostomy may be performed (see page 135).

Bacon establishes an anastomosis between the sigmoid flexure and the rectal portion of the bowel below the stricture, employing a Murphy button for the purpose. Rotter performs **sigmoidoproctostomy** in the case of the female as follows: A median abdominal section is followed by double ligation of the sigmoid and division between the ligatures. The peripheral end is closed by suturing and the central end is cleansed and wrapped in antiseptic gauze. The abdominal wound is now packed provisionally. An incision is made in the median line of the posterior vaginal wall and the rectovaginal septum split transversely to uncover the anterior rectal wall to the height of Douglas's cul-de-sac. The central end of the sigmoid is now brought down and sutured in a longitudinal slit made in the rectal wall. The suturing is done on both the mucous membrane and the outer surface, the sphincters being dilated in the former case. The rectovaginal space is tamponed.

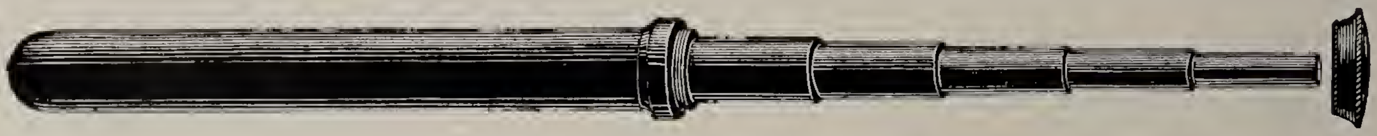

Fig. 489.—Nest of Rectal Bougies.

Malformations of the Anus and Rectum.—**Imperforate anus of congenital origin** results from failure of union between the embryonic intestine and the anal opening as the latter forms from involution of the epiblast. The disturbance in development may take place while the rectum is still in communication with the allantois (the urachus, embryonic bladder, and Wolffian ducts) and a continued communication with the urogenital apparatus result. In some cases the rectum ends blindly near the site of the anus, and a simple incision will insure relief at once, or a thick layer of tissue may intervene (Fig. 490, *A*). In other cases the anus and rectum may both be absent (Fig. 490, *B*), a shallow depression taking the place of the former

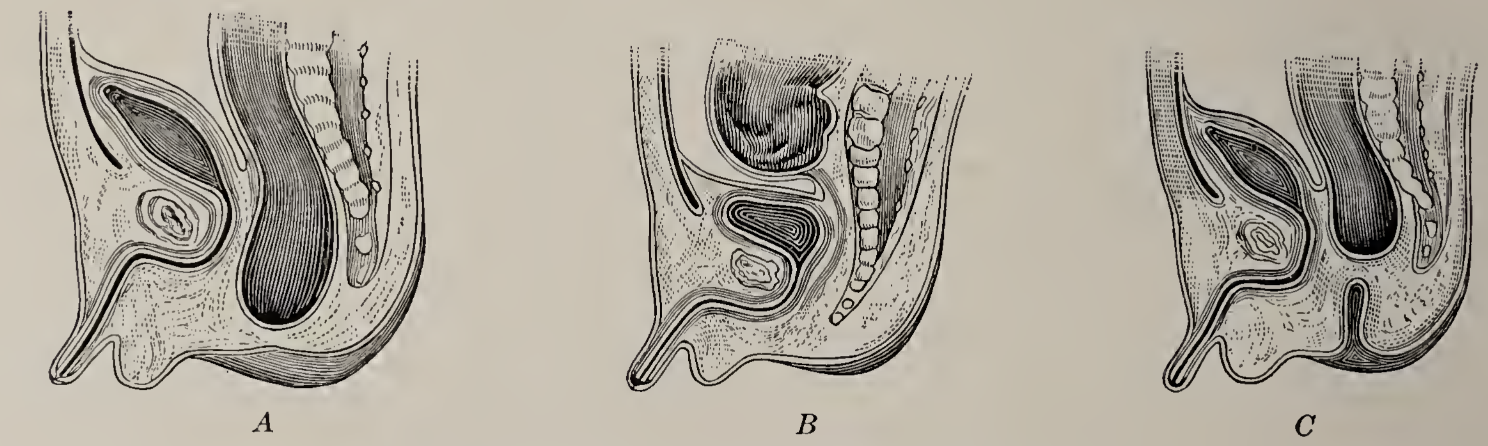

Fig. 490.—Imperforate Anus (Esmarch).
A, Thick layer of tissue intervening between the rectum and the site of the anus; *B*, occlusion of the rectum; *C*, imperforate rectum.

and a solid cord taking the place of the latter (**occlusion of the rectum**). In **imperforate rectum** the bowel is closed, the anal orifice being present but ending blindly. In **congenital cloacal openings** (Figs. 491 and 492) there are abnormal outlets of the rectum, these opening into the bladder, the urethra, the glans penis, the vagina in the female, and rarely into the uterus.

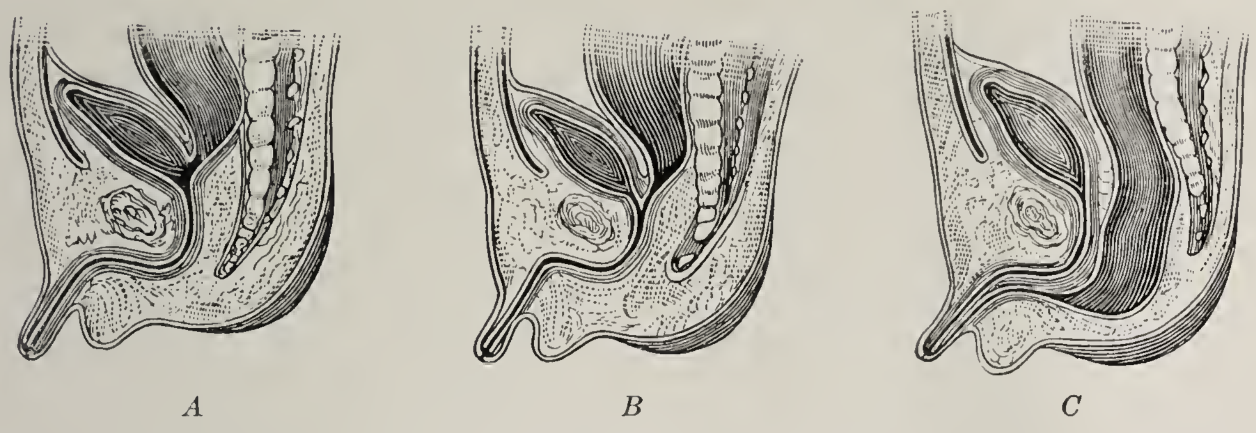

Fig. 491.—Imperforate Anus with Different Cloacal Openings. Male. (Esmarch.)
A, Terminating in bladder; *B*, terminating in the urethra; *C*, terminating at the meatus.

In cases in which the opening is into the vagina the malformation may not be discovered until some time has elapsed.

The Treatment of Imperforate Anus.—Operation should be undertaken as early as possible. The most favorable cases are those in which there is only a thin septum to be divided. The opening thus made should be enlarged with a blunt bistoury and the mucous membrane sutured to the skin.

In cases in which there is a thick layer of tissue intervening, inguinal colostomy should be performed to give immediate relief. When the parts have healed soundly, a formal attempt at proctoplasty may be made, with a flexible bougie introduced at the artificial anus and passed in a downward direction as a guide. With the patient in the lithotomy position an incision is made near the normal opening of the anus, and the incision deepened to approach the bougie passed from the artificial anus. A catheter is passed into the urethra in male children and the little finger of the operator guards the vagina in females. When the end of the rectum has been found, it should be loosened in all directions as freely as possible without opening either it or the peritoneal cavity. It is then brought down, opened, and the mucous membrane sutured to the edges of the skin wound. If this cannot be done, it should be brought down as low as possible and sutures applied. Stromeyer proposed to perform abdominal section and lead a loop of intestine into the cul-de-sac of Douglas, where it is to be sutured to an opening in the perineum.

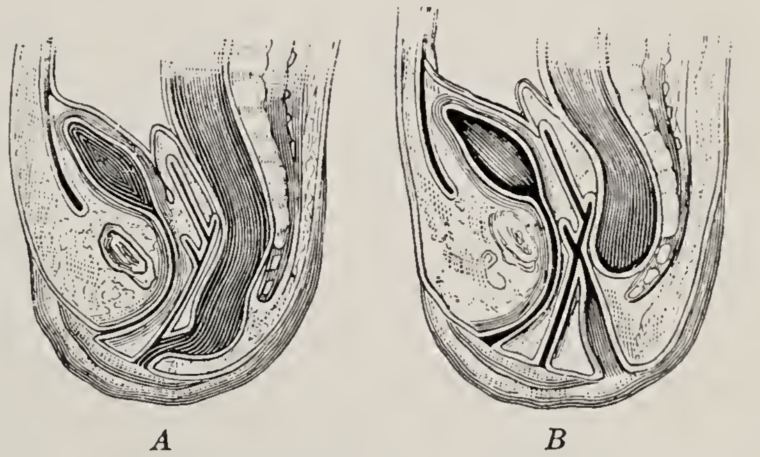

Fig. 492.—Imperforate Anus with Different Cloacal Openings in Female Children (Esmarch).
A, Terminating in the vagina near the vulva; *B*, ending as a blind pouch, opening leading from anus to upper portion of vagina.

Esmarch recommends entering the peritoneal cavity through the perineum and suturing one of the lower loops of intestine in the wound.

Many of these cases prove fatal from septic peritonitis or from extensive cellulitis at the site of the wound. The tendency to subsequent cicatricial contraction must be guarded against by the occasional introduction of rectal bougies.

Diverticulum of the rectum, analogous to Meckel's diverticulum of the ileum, is an extremely rare condition. Three cases are recorded, those of Hulke, Maas, and Terrier. In Hulke's case the diverticulum resembled the rectum in structure and ran parallel to the latter for several inches; it was lined with mucous membrane. In Maas's case an immense diverticulum containing gas and liquid feces in a child of thirteen was the cause of sudden death from pressure, the post mortem revealing the malformation. In Terrier's case the patient complained of a feeling of weight in the rectum. Examination disclosed a diverticulum which communicated with the rectum by a narrow orifice and which was filled with feces. The rectum was also dilated. A fullness in the entire rectal fossa corresponded with the site of the diverticulum. The latter was carefully excised.

Carcinoma of the Rectum.—Carcinomatous growths in this region usually arise in the glandular structures of the mucous membrane. The submucosa, the muscularis, and finally the perirectal connective tissue are invaded in turn. In the later stages of the disease, owing to ulcerative and necrotic changes, the nature of the growth is demonstrable only at the periphery. **Epithelial carcinoma** or **epithelioma** commences in the most superficial layers of the mucous membrane and gradually extends to the deeper portions. It occasionally arises at the mucocutaneous junction, either in the squamous cells of the outlying skin of the anus or in the cylindric cells of the mucous membrane. **Colloid carcinoma** is the result of degeneration of simple carcinoma and occurs as massive, grayish, and soft or gelatinous growths.

In the majority of cases of rectal cancer the growth is situated about an inch from the anus. It may occur as sharply circumscribed nodules or more diffuse papillary growths. It may be limited to a portion of the gut, in which case the anterior wall is most frequently affected, or it may involve the whole of the circumference. Early infiltration, followed by stenosis, and finally ulceration, occurs. The latter is characterized by a hard base with infiltrated edges.

The rectum above the point of stenosis becomes dilated from retention of fecal masses, and the relaxed mucous membrane may be forced valvelike against the stricture and cause complete obstruction, or the latter may occur from complete obliteration of the growth. The bladder and prostate in the male and the vagina and uterus in the female may become involved during the progress of the disease. The peritoneal cavity may be invaded and septic peritonitis ensue on rupture of a peritoneal abscess. The skin may become involved, and this, together with perforation of the rectum, lead to the formation of **fecal abscesses.** Secondary deposits may occur in the liver through the portal circulation. Infection of the retroperitoneal lymphatic glands in the hollow of the sacrum is present in advanced cases. Involvement of the anal region causes carcinomatous infection of the inguinal glands.

The **symptoms** are (1) constipation due to stenosis; (2) the discharge of blood and pus consequent upon the ulceration, and a thin serosanguinolent and ichorous fluid in addition; (3) progressive cachexia. The patient may suffer but little or no pain at first; later, when ulceration has occurred, and particularly after the growth has broken through the rectum, the patient suffers greatly. After perforation of the bladder wall there is escape of urine. The first two symptoms should call attention to the probability of the presence of the disease and lead to an examination.

Diagnosis.—The disease is easily recognized by the touch, the densely infiltrated tissues differentiating it from all other forms of rectal disease except syphilitic ulcerations. In doubtful cases portions of the new growth should be removed for microscopic examination and iodid of potassium administered as a test. In cases of broad annular deposit the latter breaks down in the middle first, and the examining finger may distinguish two points of constriction corresponding to the indurated margins of the infiltration.

The **prognosis** is exceedingly unfavorable. In cases not subjected to operation death with extreme suffering takes place in from one to two years.

Treatment.—Operative interference is indicated, except in the most advanced cases. In cases in which the limits of the disease can be defined below the third sacral vertebra by the index-finger in the rectum, and in which no involvement of the retroperitoneal glands can be made out, extirpation by the peritoneal route may be attempted. The dangers of the operation relate principally to hemorrhage and septic infection of the peritoneum, though the latter is not dreaded so much as formerly. The higher the extirpation, the larger the branches of the hemorrhoidal arteries encountered. Cases involving the bladder, prostate, or vagina, in which adhesions to the sacrum have taken place, are inoperable. **Palliative measures** in such cases consist of curetting with the sharp spoon, cauterizing with the thermocautery, and establishing an artificial anus (**colostomy**). The latter is useful, even before the occurrence of complete obstruction, to alleviate the pain and arrest the progress of the disease by removing the irritation due to the presence of fecal masses. The sigmoid flexure should be divided, its upper end sewed into the wound and the lower end closed and dropped back into the peritoneal cavity. Cases of recurrence are to be treated in the same manner as cases originally inoperable.

In operable cases a **preliminary inguinal colostomy** is sometimes useful. By this means thorough preliminary disinfection is assured and all sources of irritation are removed. Inguinal colostomy is more easily cared for as to cleanliness than an artificial anus in any other situation, and since in every case of extirpation of the rectum an artificial anus is necessary, its preliminary establishment is a step in the final radical procedure.

The Operative Treatment of Carcinoma of the Rectum.—The bowel is thoroughly evacuated by purgatives and enemas; it should also be irrigated with saline solution, the anal margins being well separated by the fingers just before the operation. The patient is placed in the lithotomy position. If the disease is confined to the anus and the region of the sphincters, an elliptic incision running parallel to the fibers of the external sphincter and well beyond the limits of the disease is made, from which a straight incision is carried sufficiently far back to permit removal of the coccyx (Fig. 493). The anal opening is closed by a continuous through-and-through suture of heavy silk. The perirectal tissues are separated to a safe point above the disease; a sound is passed into the bladder as a guide, to prevent injury to the bulb of the urethra. The operation is completed by a transverse cut made in the healthy rectal wall well above the disease. The stump is grasped to prevent retraction until the vessels are secured. A large sized rubber tube is passed into the rectum and secured to the stump by catgut sutures. The parts around the tube are packed with gauze. Suturing the edge of the opening in the rectum to the skin is not necessary and may prove fatal. In my experience, primary union has seldom taken place, and retention of secretion during the first two days has been fraught with danger of extensive virulently septic cellulitis. The gauze packing should be removed and replaced several times daily, copious sublimate irrigation being performed at the same time.

The incontinence which follows may be remedied in a measure by detaching the rectum after healing is completed, twisting it on its long axis and suturing it in this position (Gersuny).

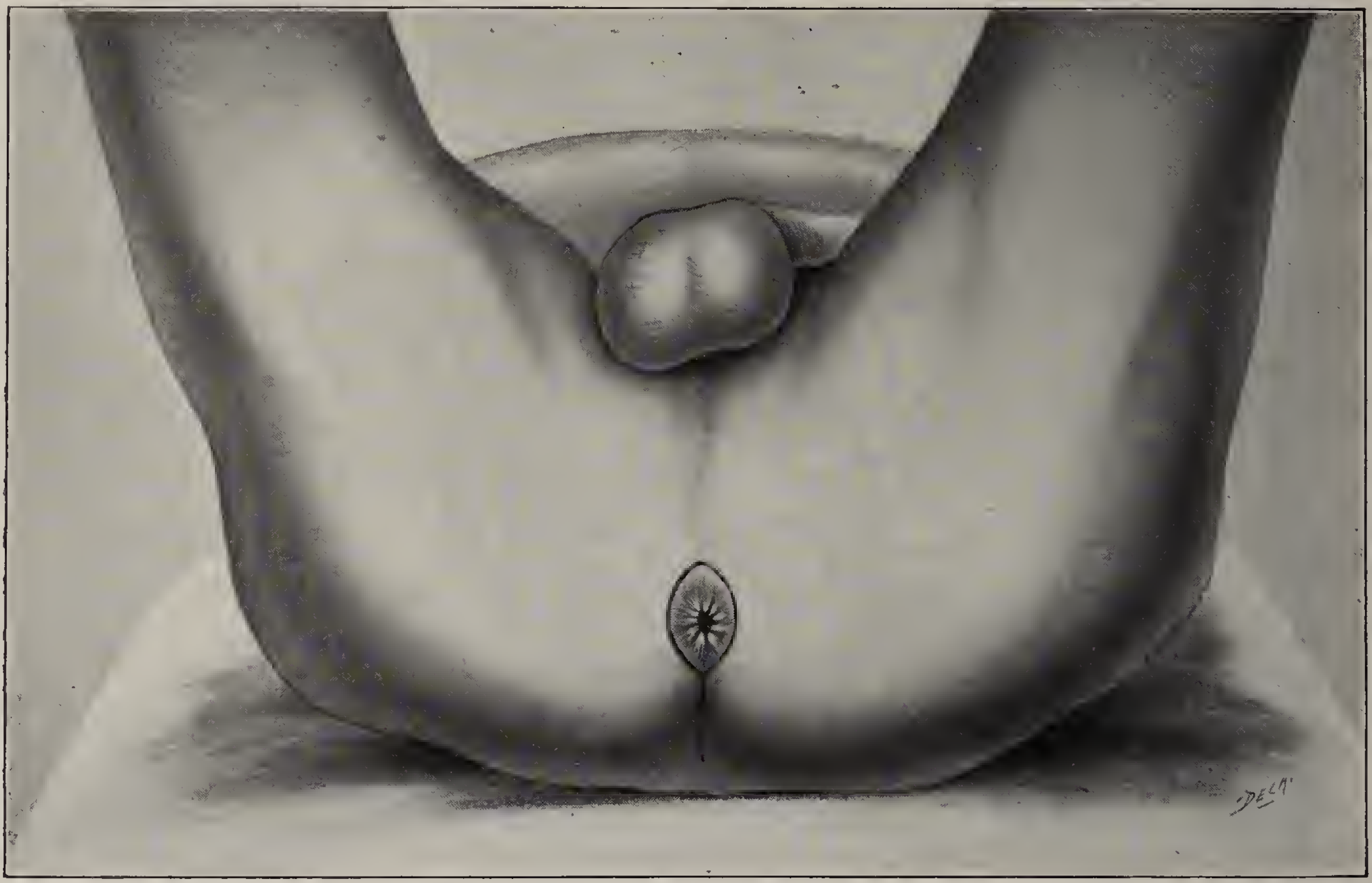

Fig. 493.—Resection of the Rectum by the Perineal Route.

In cases in which the **parts immediately above the sphincter are involved,** the latter remaining free from disease, Hueter made a horseshoe-shaped incision with the curved portion placed just behind the scrotum, the two sides running along the outer edge of the external sphincter. The flap containing the sphincters is turned back, the rectum exposed and the diseased portion resected, after which the upper stump is sutured to the anal portion and the flap replaced and partially sutured.

Vaginal Extirpation of the Rectum.—In cases in which the sphincters are not involved Rehn operates as follows: The rectum is thoroughly emptied and tamponed. With the patient in the lithotomy position, a median incision is made in the posterior vaginal wall and the latter freed on each side. The dissection is then deepened and extended into the ischiorectal fossas to each tuberosity of the ischium. To facilitate this the incision is carried downward and backward on each side of the anus. The first cross-incision of the rectum is made from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch above the upper sphincter, if the location of the disease will permit this. After extirpation of the diseased portion the peritoneum is closed and the rectal stump sutured to the anal ring, this at once closing the bowel. The central end of the rectum is detached sufficiently high up to avoid tension. This method offers the advantage of permitting simultaneous attack on the uterus, the vagina, and the perineum.

Campeňon divides the bowel between two ligatures above, in order to guard against fecal infection. In cases of involvement of the sigmoid flexure the combined abdominal and vaginal route is to be selected, with the formation of an inguinal artificial anus (Schwartz).

Extirpation of the Rectum by the Combined Abdominal and Perineal Route.—Quénu operates as follows: With the patient in the Trendelenburg position the abdomen is opened in the median line, both internal iliac arteries are ligated, and enlarged glands sought for and removed. In ligating the left internal iliac, the mesosigmoid is separated, or, in case of a long mesentery, the sigmoid is turned upward and the vessel approached directly. The sigmoid flexure is divided between two strong silk ligatures and the cut edges disinfected and wrapped in gauze. The upper cut end of the rectum is sutured in the left iliac region, the ligated portion being placed extra-abdominally. An assistant makes traction on the sigmoid and rectum, the mesorectum on each side is freed, and the band which contains the hemorrhoidal vessels is sought for as it passes downward from the promontory of the sacrum, and ligated. The rectum is now bluntly loosened from the sacrum as far in a downward direction as possible, and the rectovesical or recto-uterine peritoneal pouch incised, if this can be brought within reach. The rectum and the remains of the sigmoid are wrapped in gauze and the abdominal wound closed. The operation is now continued from below. The bowel is loosened by incisions which embrace the anal region, and finally removed. The resulting cavity is tamponed with gauze and partly sutured.

This operation offers the advantages of certainty of asepsis and radical removal of all affected tissues. The silk ligature on the projecting portion of the bowel in the left iliac region is removed on the third day, the resulting opening forming an artificial anus.

Extirpation of the Rectum by the Sacral Route.—The incision is made in the posterior raphe. Kocher resects only the coccyx. Kraske and Bardenheuer remove a portion of the sacrum as well. The sacral route is sometimes chosen in cases in which the diseased mass is situated too high for the perineal route and is too low and fixed to allow of removal of the rectum by abdominal section (Volkmann). The operations by temporary resection or removal of a portion of the sacrum are exceedingly severe and should be performed only on patients with good recuperative power. They may be replaced largely by Quénu's operation (*vide supra*).

Kraske's Method.—The patient is placed on the right side. The skin incision commences near the anus and extends in the middle line to the middle of the sacrum. The left edge of the sacrum and the coccyx are exposed and the sacrosciatic ligaments of both sides divided. A portion of the left border of the sacrum is now chiseled away (Fig. 494). The section of the bone commences on a level with the third posterior sacral foramen, curves inward and downward with its concavity to the left, passes the lower border of the third sacral foramen and through the fourth foramen. The patient is now placed in the lithotomy position with the pelvis well elevated, the posterior wall of the rectum is divided longitudinally and the extirpation completed. If the anal portion is not involved, it is to be spared. Otherwise, the incision is to be carried forward on both sides of the anus in order to accomplish complete removal.

Bardenheuer's method consists of transverse section of the sacrum as high as possible short of actually encroaching upon the third sacral foramen. The patient is placed in the lithotomy position with elevated buttocks. A posterior median incision is made from the middle of the sacrum to the anus; this is extended by an incision on each side of the latter, these latter incisions meeting in front if this portion of the gut is involved. The soft parts are dissected back, the edges of the sacrum and coccyx exposed, and, after division of the sacro-ischiatic ligaments and removal of the coccyx, the sacrum is divided at the required height with the chisel, bone-cutting forceps, or the Gigli saw, and excised. The rectum is then exposed and separated by blunt dissection, care being taken to draw it well backward in order to avoid injury to the bladder and urethra. If the sphincters ters are to be preserved, a silk ligature is passed around the rectum and the latter divided transversely below the ligature. In effecting the separation of the rectum above, the peritoneum is carefully pushed upward, tearing of the structure being avoided if possible. Should this occur, it is to be closed with catgut after any coils of intestine that may prolapse have been thoroughly disinfected. After the rectum above the point of the disease is divided the central stump is to be brought down and sutured to the anal stump, if the sphincters have been preserved, the latter being divided posteriorly to facilitate escape of fecal matter. Otherwise it is to be sutured to the anal region by a few tension sutures.

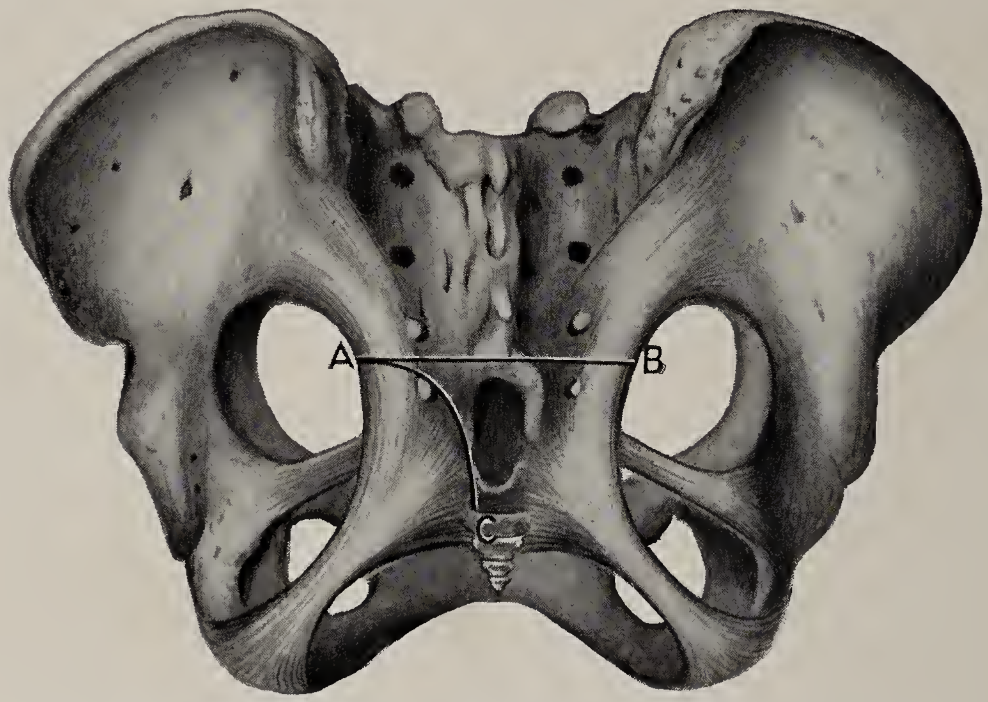

Fig. 494.—Lines of Incision for Excision of the Rectum.
A, B, Bardenheuer's incision; A, C, Kraske's incision.

Hochenegg places the patient on the left side with the knees and thighs well flexed, and makes a curved incision with its convexity to the right, extending from the middle of the left sacro-iliac joint across the median line, and terminating at the right edge of the coccyx, an incision embracing the anus being added to this if the anus is to be removed. The coccyx is enucleated and the left wing of the sacrum removed by chiseling.

Schlange reflects downward an osteoplastic flap consisting of a part of the sacrum and the coccyx, and the overlying soft parts. A transverse incision is made down to the bone across the sacrum just below the level of the last sacral foramen. From each end of this transverse cut an incision is made in a downward direction, these two incisions diverging from each other slightly, and terminating near the level of the anus, where they merely penetrate the skin. The muscles and liagments attached to the bone are divided. The sacrum is divided transversely with a Gigli saw. The further steps are the same as in the Kraske operation. The wound cavity is loosely packed with gauze and the flap containing the sacrum and coccyx partly sutured. The patient lies on his side during the after-treatment.

Right inguinal colostomy is sometimes employed as a palliative measure in carcinoma of the rectum; as a preliminary step in the operation for radical cure of the latter, for obstructions of the large intestine other than those occurring in the anal region or rectum, and for the purpose of securing rest in cases of otherwise intractable ulceration and affording facilities for irrigation in the treatment of the latter. A two-inch incision is made parallel to Poupart's ligament and from one and a half to two inches above the outer portion of it. The abdomen is opened as in an abdominal section and the parietal peritoneum sutured to the skin edges. The colon is identified and drawn out of the wound from above downward until no more of it will come. About one-half of the circumference of the colon on its anterior surface is now secured by chromicized catgut sutures to the part of the abdominal wound which it approximates. If the case is one of inoperable cancer of the rectum, a clamp forceps is placed across the gut just beyond the abdominal surface, to prevent soiling, and the colon is divided transversely. The lower end is closed by turning in its edges and suturing across so as to bring its serous surfaces in apposition, and dropped into the abdomen. The suturing of the protruding upper end is now completed, the clamp removed, and the superfluous portion trimmed away.

In cases in which the colostomy is to serve a temporary purpose, the presenting portion is sutured to the abdominal wound and opened at once, if the exigencies of the case demand it; otherwise this may be delayed for a day or two.

Carcinoma of the Anus.—The anus may become invaded in rectal cancer or the disease may occur primarily at this point. It is rare before the age of forty and affects women more frequently than men. It is very commonly believed by the patient to be "an attack of the piles" at the commencement. The growth is of the squamous-celled variety. The inguinal glands are affected on one or both sides in about fifty per cent of the cases. Unless removed early and completely it destroys life in about a year.

Benign Tumors of the Anal Region and of the Rectum.—Exclusive of hemorrhoids, benign tumors in this region are rare. **Multiple**

papillomas of the anal region sometimes occur and may attain a considerable size. They are attached by a broad base and resemble condylomas. Among the other tumors found in this region, **soft fibromas, angiomas,** and **sebaceous cysts** are to be mentioned. **Perirectal lipomas** originate in the lesser pelvis but sometimes advance in the direction of the skin surface and appear near the anus. In other cases they encroach upon the rectal wall and force the mucous membrane of the latter through the anal opening, appearing in this situation. Their operative removal is accomplished by incising through the skin into the perirectal tissues and dragging the lipomatous structures out of the pelvic cavity. Hemorrhage is arrested by packing both the cavity of the rectum and the space left by the removal of the growth.

In the rectum itself there are found small pediculated tumors, so-called **rectal polypi,** springing from the mucous membrane. They occur by preference in children and are temporarily forced from the anal opening during defecation. When of large size, rectal polypi may produce invagination of the rectum in the expulsive efforts which they occasion. The pedicle may be torn across and the tumor evacuated during defecation. They are a combination of fibromas, proliferations of the mucous membrane, and hypertrophied glandular tissues. A number of these polypi are sometimes observed in the same individual. They are easily recognized by their thin and pale pedicle, and the deep red color of the tumor itself. **Papillomas** of the rectum occur either as warty growths, or in the adenomatous form with globular surface; the latter consist largely of hypertrophied and newly formed mucous glands and are the most frequently observed of this variety. Benign tumors of the rectum increase temporarily in size when extruded from the rectum but return to their former dimensions when reduced. Cystic tumors of the rectal mucous membrane are very rare. They have been observed in the shape of dermoids. **Myomas** as well as **fibromas** of the rectal wall sometimes advance in the direction of the peritoneum, where they may be mistaken in females for growths springing from the uterus or its adnexa.

In the **treatment** of rectal polypi, these are seized when extruded, secured by a ligature thrown about the pedicle, and excised. The stump is cauterized with the thermocautery. The other benign tumors in this region are extirpated according to general rules. Myomas and fibromas which have invaded the peritoneal cavity should be removed by abdominal section. No tumor of the rectum should be neglected because of its supposed benign character, since there may be an error in this regard. Even in cases in which there is any reason to suppose that the tumor is not malignant in the first place, clinical experience teaches that it may ultimately become so.

Hemorrhoids or Piles.—These are tumors occurring at the lower end of the rectum originating in diseased conditions of the blood-vessels resulting in dilatation and proliferation of the latter. The causes usually ascribed are (1) the absence of valves in the system of veins of the interior of the rectum as these converge to the superior hemorrhoidal vein, which, through the inferior mesenteric vein, forms a part of the portal circulation; (2) the upright position; (3) the fact that the veins leave the rectum obliquely through slitlike openings in the muscular walls of the bowel, where they are frequently subjected to pressure, particularly if there is a habit of constipation; (4) obstruction to the portal circulation arising from disturbances at the liver. Hemorrhoids are specially frequent at and after the middle period of life and are extremely rare in children. Stone in the bladder, urethral obstruction, and the excessive use of purgatives are also predisposing causes.

Classification.—Hemorrhoids are classified as external and internal. **External hemorrhoids** arise external to the sphincters and are covered by the anal skin, while **internal hemorrhoids** are covered by mucous membrane. Those covered by both anal skin and mucous membrane and external piles directly continuous with internal ones, are called **interno-external.** External piles having undergone inflammatory changes in which the venous character of the tumor is destroyed, leaving a simple "tab" of skin, either pediculated or having a hard base in the radiating folds at the anal margin, are called **cutaneous hemorrhoids.**

Symptoms.—A dilated and varicose condition of the veins of the lower portion of the rectum may exist for a long time without giving rise to troublesome symptoms, other than a sense of dragging and itching. A phlebitis may occur in the diseased vessels as the result of constipation, errors in diet, and similar causes, resulting in thrombosis; this is called "an attack of piles." In **external hemorrhoids** the tumors become swollen and inflamed, together with the skin in the neighborhood, painful spasmodic contractions of the levator ani and sphincter occur, and there is a feeling as of a foreign body in the rectum, with painful tenesmus. The symptoms are aggravated by coughing, sneezing, etc., and movements of the bowels are exceedingly painful, particularly if constipation exists, the pain lasting for several hours. Examination reveals one or more dark purple and acutely tender tumors of varying sizes, in the anal region, with tense, glistening surfaces. There may be considerable constitutional disturbance, with fever, furred tongue, etc. The most important symptom of **internal hemorrhoids** or **bleeding piles** is bleeding. The delicate and highly vascular mucous membrane is bruised and lacerated as the result of the passage of hard feces and it bleeds freely, the termination of the act of defecation being followed by a flow of blood, which may continue for some time after evacuation is complete. Later on, the piles may become ulcerated, the bleeding is not confined to defecation, and considerable blood may be lost, even to the extent of producing acute anemia and fatal syncope. Mucous discharge is sometimes present, which may be acrid and irritate the perineum, giving rise to soft warty growths simulating syphilitic condylomas. Pain is not commonly complained of in internal hemorrhoids except when they are strangulated or acutely inflamed. There is, however, more or less discomfort and a sense of fullness in the parts; in some cases this is felt in the lumbar region and perineum. During defecation, the bulk of the hemorrhoids is increased by congestion, and they are forced downward within the grasp of the sphincter, where they give rise to distressing tenesmus. The sphincters contract spasmodically on the hemorrhoidal mass, giving rise to increasing and agonizing pain and efforts at expulsion, which are relieved only when the patient succeeds in replacing the piles within the rectum. **Strangulation and gangrene** may arise from failure of reduction; the latter may also occur from infection and inflammation following lacerations or abrasions. In cases of long standing the piles pass outside the relaxed sphincters independently of acts of defecation and may even become permanently prolapsed, together with the mucous membrane from which they spring. This is followed by the development of external and of interno-external piles.

Hemorrhoids may be symptomatic of rectal stenosis or they may be associated with diseases of the heart and liver. In females, a hemorrhagic flux from the rectum sometimes replaces the menstrual flow, and in cirrhosis of the liver and atheromatous vessels, in persons of a full-blooded habit, the flow of blood may be compensatory and hence salutary.

The differential diagnosis must exclude (1) polypi; (2) villous tumors; (3) malignant growths; (4) prolapse; (5) pruritus ani; (6) hemorrhages from causes other than piles. Polypi are pediculated growths and are further distinguished by their soft, smooth, and elastic feel and pyriform shape. Villous tumors resemble hemorrhoids more than they do polypi. They are attached by a broad base and bleed easily. They have a dark red color, while internal hemorrhoids are dark blue. They are of slow growth and have a spongy feel. The hard nodular deposits of malignant disease are characteristic. In prolapse the entire circumference of the bowel is symmetrically involved, while hemorrhoids present as distinct tumors. In pruritus ani there is an absence of both tumors and hemorrhage. Hemorrhages from the rectum other than those arising from piles may be due to ulceration, injury, fissure, or malignant disease.

The Treatment of Hemorrhoids.—A knowledge of the causes of hemorrhoids will at once suggest the principles of prophylaxis.

External hemorrhoids when uncomplicated and quiescent require no special treatment except cleanliness of the parts. They should be carefully cleansed after each act of defecation. Should they become inflamed, the treatment is either palliative or operative; preferably the latter. The **palliative treatment** consists in the avoidance of highly seasoned food and such stimulants as whisky, wine, and beer; the use of some mildly purgative mineral water, and occasional $\frac{1}{10}$-grain doses of calomel. Hot baths and pure soap and warm water are useful. An ointment containing sulfate of morphin dr. j, acetate of lead dr. j, and vaselin oz. j, may be applied. Pledgets of absorbent cotton soaked in a 2.5 per cent solution of carbolic acid, to which tincture of opium has been added in the proportion of 2 drams to 4 ounces, are very useful. Hot poultices made with this lotion are valuable in relieving pain and reducing inflammation.

The operative treatment of external hemorrhoids in cases in which thrombophlebitis exists (**inflamed piles**) consists in incising the pile or piles freely, turning out the clot and applying carefully to the interior pure carbolic acid, neutralizing it at the end of a minute with 95 per cent alcohol. The patient should be placed in bed for a few hours. In the after-treatment cleanliness is to be observed and the parts dressed with boric acid ointment.

Cutaneous hemorrhoids, if they become a source of annoyance, may be removed with the catch forceps and scissors. A few fine catgut sutures may be applied to fill up the skin gap, if this is considerable. If only one or two small tumors are present, the excision can be performed under local cocainization without previous divulsion of the sphincter. Otherwise it will be necessary to establish general anesthesia or possibly spinal cocainization and divulse. Stricture may result by leaving large surfaces to heal by granulation.

The Treatment of Internal Hemorrhoids.—When the piles are small and cause but slight suffering, **palliative treatment** should be employed consisting of correction of errors of diet and habits of living. The bowels should be kept open regularly and the habit enforced of having a movement at stated intervals of at least twelve or twenty-four hours. When protrusion occurs, the recumbent position should be assumed, quiet enjoined, and soothing and astringent applications employed, such as the lead and opium lotion, or the ointment of opium and galls. The application of ice is often useful. Hot poultices of flaxseed made with the lotion of carbolic acid and laudanum (*vide supra*) are of service in affording relief. A few $\frac{1}{10}$-grain doses of calomel, followed by a saline cathartic, are to be prescribed in cases of congested liver. The protruding hemorrhoids must be returned above the sphincter as soon as possible. Flushing the rectum with cold water in which boric acid is dissolved is useful in relieving the inflammation and congestion present. A permanent cure can be obtained only by **operative treatment.** In preparing the patient for operation, a licorice powder or saline purge should be administered the morning before the operation. An enema should not be given, the rectum being thoroughly cleansed with soap and water and irrigated after the anesthetic is administered and the **sphincter ani dilated** or **divulsed.** The latter is best accomplished as follows: The two thumbs, previously well covered with vaselin, are one after the other introduced with their dorsal surfaces in contact, and the divulsion made by forcing the thumbs apart and at the same time rotating them on their long axes. In this manner every portion of the two halves of the sphincter is acted on by movements of massage. Care must be taken not to divulse too rapidly. The process should be gradual rather than rapid, lest rupture of the muscles occurs. The most convenient position is that employed for lithotomy, with the pelvis elevated on a sand pillow. The ether cone or chloroform mask should be withdrawn during the divulsion in order to avoid dangerous narcosis from the deep inspirations excited by the manipulation of the sphincters. A plug of gauze attached to a string and well lubricated with vaselin should be introduced high up in the rectum to prevent the field of operation from becoming flooded with fecal matter.

Four methods of operation are available at the present time. These are the following: (1) injection; (2) excision by Whitehead's method or some of its modifications; (3) the method of combined catgut ligature and cautery; (4) the clamp and cautery; (5) the silk ligature.

The method of injection is suited only for small, isolated, and pendulous piles which can be readily brought within reach. It is contraindicated in large and hypertrophied hemorrhoids, as well as in cases where the piles are inflamed. The indiscriminate use of this method may be followed by great pain, sloughing, the formation of abscesses followed by fistula, and suppurative hepatitis. The method is tedious, the cure only partial, except in the selected cases mentioned, and death may result from pyemia. If this method is to be employed, every preliminary precaution relating to a thorough preparation should be taken. A small rectal speculum is introduced, the pile selected for injection brought within reach, and the injection made in its pendulous portion (never at the base) by means of an ordinary hypodermic syringe that has been sterilized by boiling. The needle is not to be withdrawn until the pile turns white. In withdrawing the needle place the index-finger over the puncture to prevent the escape of the injected fluid and to arrest the hemorrhage. The following solution, employed by Prof. Tuttle, of New York, answers the purpose. Carbolic acid, dr. iss; salicylic acid, dr. ss; borax, dr. j; sterilized glycerin, oz. j. Only one or two piles are to be injected at a time; the quantity for a small pile should not exceed from 2 to 5 drops, and for a large pile from 5 to 10 drops. When the injections are completed, the piles should be promptly replaced and the patient kept in the recumbent position for half an hour.

Whitehead's Operation.—The mucous membrane is divided at its junction with the skin (Hilton's "white line") around the entire circumference by means of scissors. The sphincters are exposed by rapid dissection, and the pile-bearing area of mucous membrane with its attached hemorrhoids drawn down so that the latter appear below the margin of the skin. The mucous membrane above the hemorrhoids is now divided in successive stages by the scissors, each cut of the latter being followed at once by suturing with silk the severed mucous membrane to the corresponding free margin of the skin. These sutures are allowed to come away of themselves.

This operation is unnecessarily severe for the average case. Its employment should be limited to cases of long standing in which there are no distinct hemorrhoidal tumors, the veins of the rectal wall being diseased and dilated. Union by first intention may fail, in which case the extensive granulating surface is liable eventually to lead to stricture. Paralysis of the sphincter may also occur. These two conditions may be combined, *i. e.*, the stenosis may prevent the passage of solid fecal matter, and the paralysis cause incontinence when the movements are soft (**paradoxical fecal incontinence**).

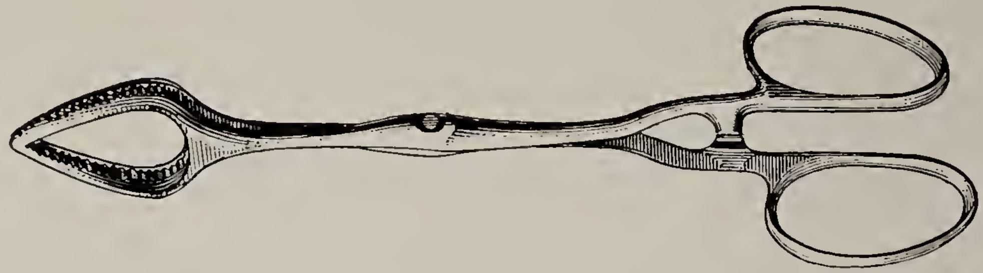

Fig. 495.—Pointed Pile-grasping Forceps.

The Method of Combined Catgut Ligature and Cautery.—After complete dilatation with the patient in the lithotomy position, each pile tumor is grasped by the pile-grasping forceps (Figs. 74 and 495) and drawn down until all the piles are identified and grasped. Each one is now dealt with separately. With pointed scissors the place of junction of the mucous membrane and skin is incised at the base of each pile as it is rolled out, and the rounded shape of the base followed for a short distance up the rectum. The latter is now transfixed by a large curved needle armed with a double thread of heavy catgut. The needle is passed with the eye first, so as to avoid puncture of the vessels at the base, and the surgeon's left index-finger is placed in the rectum as a guide to prevent the needle from encroaching upon the structure of the sphincter. With the pile drawn well forward by an assistant the two halves are tied off tightly, and two additional turns of the knot made for additional security against slipping (Fig. 496). Each pile is dealt with in the same manner. If care is taken to follow accurately the outer margin and sides of the base of the pile, there will remain parallel strips of mucous membrane corresponding to the intervals between the piles before removal, which will serve as the starting-point for the reproduction of mucous membrane during the healing process.

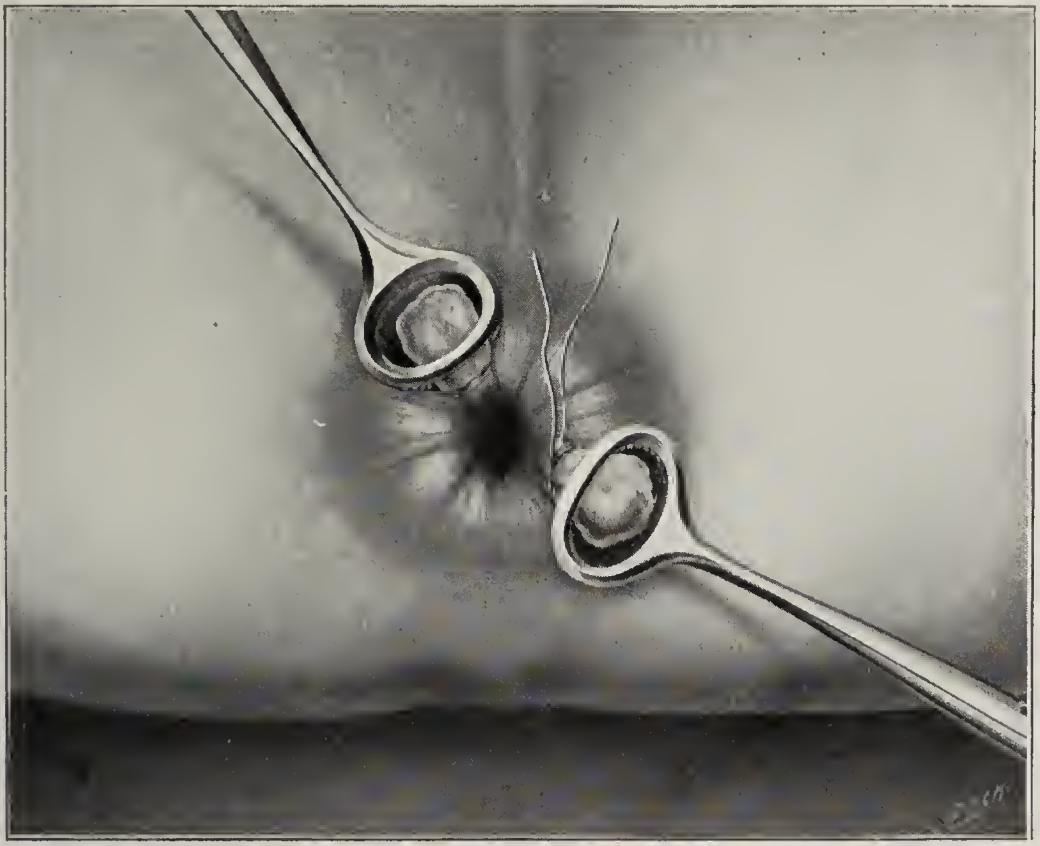

Fig. 496.—The Author's Operation for Hemorrhoids (the Combined Catgut Ligature and Cautery Method).

The upper pile shows the sulcus cut for the reception of the catgut ligature. The ligature is shown applied to the lower pile.

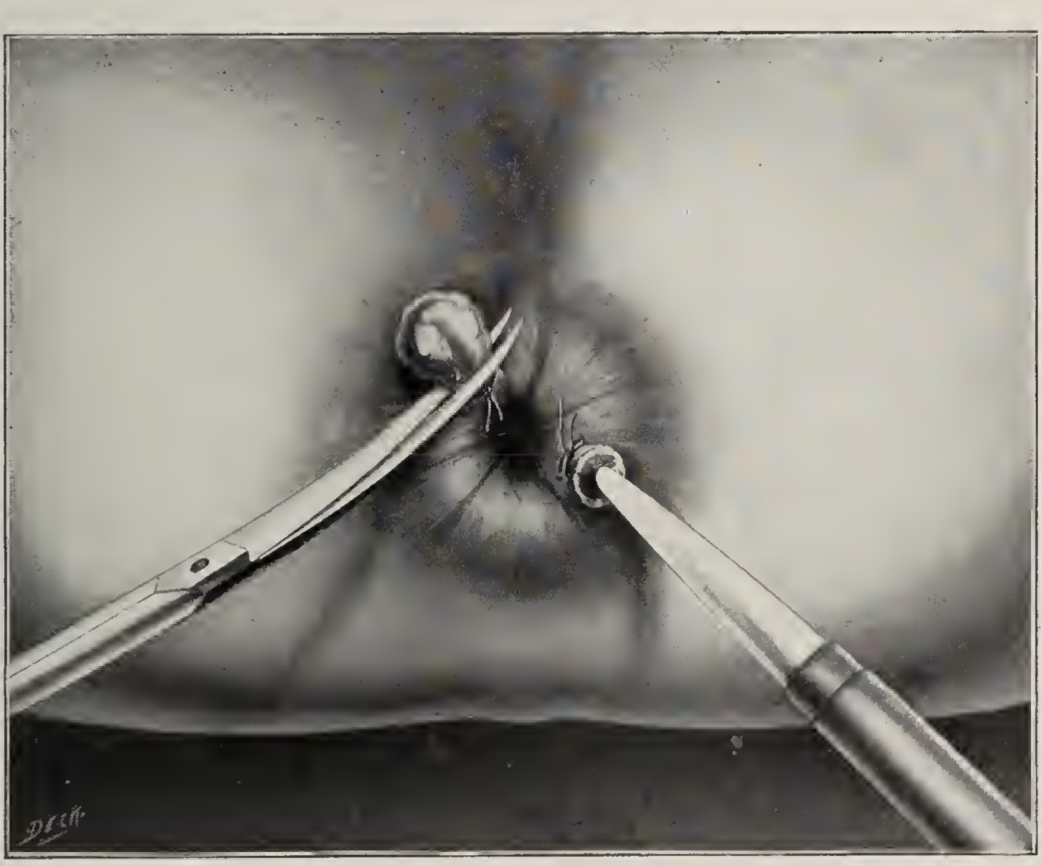

Fig. 497.—The Author's Operation for Hemorrhoids (the Combined Catgut Ligature and Cautery Method).

Cutting away the apex of the pile and applying the thermocautery.

The apex of each large pile is now cut away and the resulting raw surface slowly but thoroughly cauterized with the thermocautery. Small piles are simply cauterized at the apex after being tied. The stumps of the hemorrhoids must not be trimmed too closely lest the ligatures slip. They should now be returned within the sphincter, a suppository containing half a grain of the aqueous extract of opium and two grains of iodoform introduced, and a sterile gauze dressing applied, held in place by a T-bandage.

The Method by the Ligature Alone.—The same steps are followed as in the operation just described, with the exception that heavy silk is used in place of catgut, and the cauterization of the base of each pile after ligation and excision is omitted.

The Clamp and Cautery Operation.—The sphincter is first thoroughly dilated and each pile seized and drawn well down, as in the ligature operation. The incisions partly or completely encircling the base of the pile are made and the clamp (Fig. 498) adjusted in the incision so as to grasp the pile firmly and leave the bulk of the latter outside the clamp; the hemorrhoid is excised an eighth of an inch in front of the clamp, with the curved scissors. The stump is then thoroughly cauterized with the cautery at a dull or cherry-red heat. The clamp is then loosened and any bleeding points noted. If these occur, they will usually have to be tied, since readjustment of the clamp is often difficult and sometimes impossible. The dressings are applied in the same manner as after ligation.

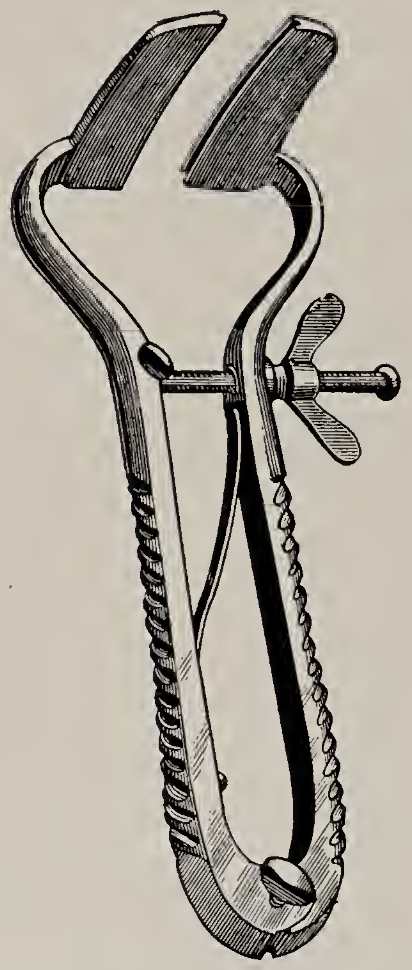

Fig. 498.—Gant's Pile Clamp.

The method of ligation of the hemorrhoids with catgut and subsequent cauterization of the stump after removal of the hemorrhoids with the scissors possesses all the advantages of the clamp and cautery method and none of its dangers. The catgut ligature simply takes the place of the clamp, guards against hemorrhage, and softens in a day or two, the cauterization being the principal factor in the destruction of the hemorrhoidal vessels. It differs essentially from the old ligature operation with silk, since the latter must slough away, a process requiring from eight to ten days. By the combined catgut ligature and cautery method patients may sit up on the second or third day. They suffer very little after-pain and may often be discharged at the end of a week. The method combines the advantages of a hemostatic and an aseptic procedure.

In the **after-treatment** of hemorrhoid operations the diet for the first four days should be restricted to liquids, or at the most semi-solids. The bowels should be moved by a saline purge on the morning of the third day, the first movement being preceded by a few ounces of cotton-seed or sweet oil, and a soapsuds enema. If soiling occurs before this, cleansing must follow at once and the dressing must be changed. Some surgeons introduce a rubber tube wrapped with gauze to facilitate the expulsion of flatus. In the absence of this the occasional use of the smooth hard-rubber rectal tube of the common fountain syringe, introduced after being well lubricated with vaselin, may replace it, when needed.

Post-operative hemorrhage occasionally occurs after the clamp and cautery operation. It is rare after the ligature method, if this is properly done. If irrigations with ice-water, very hot water, or alum water fail to arrest it, the bleeding point must be sought for. If within easy reach, it may be ligated after being clamped; otherwise after it is once secured it will be safer to leave the clamp on for a day or two, or until it loosens itself. If the bleeding point cannot be located, a gauze bag may be introduced well up in the rectum and the cavity of this lightly packed with pledgets of gauze wrung out of alum water of the strength of half an ounce to the pint.

Retention of urine may occur after any operation for hemorrhoids. The application of hot stupes over the suprapubic region and at the perineum will, without the use of the catheter, frequently bring about micturition.

Ulceration at the anal margin, extending for variable distances into the rectum, may follow the separation of sloughs after cautery operations and the casting off of the silk ligature after the old ligature operation; these will require daily cleansing. In case the points of ulceration become sluggish they should occasionally be lightly touched with the mitigated solid stick of nitrate of silver.

HERNIA

By the term "hernia" is meant the protrusion of an abdominal viscus through a normal or an abnormal opening. When used in connection with an organ, the term is qualified to denote the organ involved, as, for instance, "cerebral hernia."

Hernial protrusions appear most frequently at the anterior abdominal wall and are named after the locality in which they occur, as, for instance, **umbilic hernia,** when occurring at or near the umbilic depression; **inguinal,** when at the inguinal ring; and **femoral,** when at the place of exit of the femoral vessels. These are the favorite locations of hernias. In addition to these, hernias appear at other weak points in the abdominal wall, as **ventral hernia,** in which the protrusion occurs at any point of the abdominal wall other than at those just mentioned; **obturator hernia,** in which the hernia protrudes through the obturator foramen and appears on the thigh; **sciatic hernia,** in which the protrusion passes through the great sciatic notch; **diaphragmatic hernia,** which protrudes through the diaphragm and enters the thoracic cavity; **lumbar hernia,** which appears between the last rib and the crest of the ilium; **perineal hernia,** or protrusion through the pelvic floor; and **vaginal hernia,** or protrusion into the vagina.

Comparative Frequency.—Inguinal hernia occurs most frequently, femoral hernia next, and finally umbilic. The following are the figures given by Eccles: inguinal, 73.41 per cent; femoral, 18.0 per cent; umbilic, 8.47 per cent. The remaining 0.12 per cent represents all other varieties. Considered in relation to sex, hernias are found as follows: in males, 96.33 per cent are inguinal, 2.53 per cent are femoral, and 1.14 per cent umbilic. In females, 50.6 per cent are inguinal, 33.5 per cent are femoral, and 15.9 per cent umbilic. Ventral hernias come next to umbilic in frequency. Hernia occurs with much greater frequency on the right side than on the left.

Hernias are further described as **traumatic** and **congenital.** The traumatic variety occurs from cicatrices following operations on the abdominal walls (**surgical hernia**). The latter drag the parietal peritoneum from within outward in a funnel-shaped depression. In the congenital variety a similar depression occurs during fetal life as a part of the process known as the **descent of the testicle.** In all varieties of abdominal hernia either the peritoneum is protruded simultaneously with the gradual progress of the viscera, or the **hernial sac,** as the protruded portion of the parietal peritoneum is called, is preformed, the viscera finding its way into the sac subsequently.* The **neck of the sac** is that portion of the protruded parietal peritoneum which is constricted in its passage through the muscular abdominal wall. The **mouth** of the sac is the opening of communication between the neck of the sac and the peritoneal cavity. The **body** of the sac, sometimes called the fundus, is the expanded portion beyond the abdominal wall (Fig. 499). The **hernial ring** comprises the muscular and tendinous soft parts inclosing the neck of the hernial sac and forming the exit for the latter. It is sometimes called the **hernial opening.**

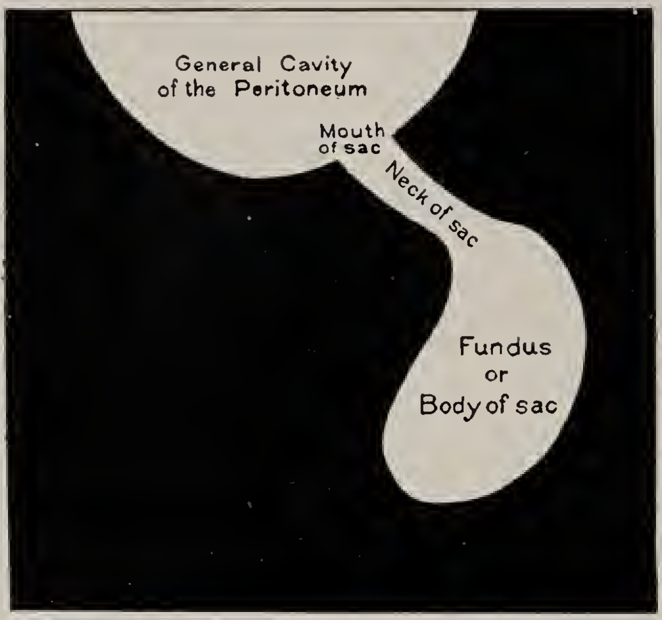

Fig. 499.—Hernial Sac.

The **hernial coverings** are made up of the layers of tissue outside the sac, these varying according to the site of the hernia. While, from the anatomic standpoint, these cannot be considered a part of the hernia itself, they possess a surgical interest on account of the importance of a knowledge of these structures in connection with operations for the radical cure of hernia.

The hernial sac usually forms slowly, the process covering a period of months. A slight bulging of the peritoneum first occurs at the site of a weak spot in the abdominal wall, which may be but temporary in the beginning, but which in time becomes permanent, through a combined process of gradual displacement and stretching, and the formation of adhesions between the protruded peritoneum and the tissues constituting its new environment. Exceptionally, however, the protrusion may occur suddenly, as in the case of a congenital hernia, the hernia descending into the vaginal process of the peritoneum the communication between which and the peritoneal cavity persists as a result of an arrest of development. A **fenestrated hernial sac** is one in which the sac wall becomes very greatly stretched and apertures form in its wall, the hernial contents coming in contact with the outside tissues. A **bilocular sac** is one in which one portion of the sac yields to the intra-abdominal pressure more than another (Fig. 500). **Hour-glass contraction** of the sac is the result of the narrowing of the mouth of the original sac and the protrusion of an additional portion of peritoneum, the latter pushing the former before it. One or more contractions may be present (Fig. 501).

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* The responsibility of accident insurance companies, as well as of corporations, when defendants at law in personal damage suits based on the occurrence of inguinal hernia constituting a portion or the whole of injuries sustained, is of interest to the surgeon who may be called on to express an opinion on the subject. The fact that the formation of the most important part of the hernia, namely, the sac, occupies a period of time extending, in some instances, over many years, and is frequently a congenital condition, and the further fact that the occurrence of the protrusion results from a gradual traction and pushing forward of a certain isolated portion of the abdominal wall, should decide the question against the contention that hernia is to be considered as resulting from an accident, particularly as a number of such hernias depend on peculiar local conditions, such as the existence of lipomas, etc. On the other hand, the occurrence of strangulation is always to be considered an accident in connection with accident insurance, and may, with the presentation of proper proof, be justly claimed as a factor in the settlement of claims in personal damage suits (W. Roser, of Marburg).

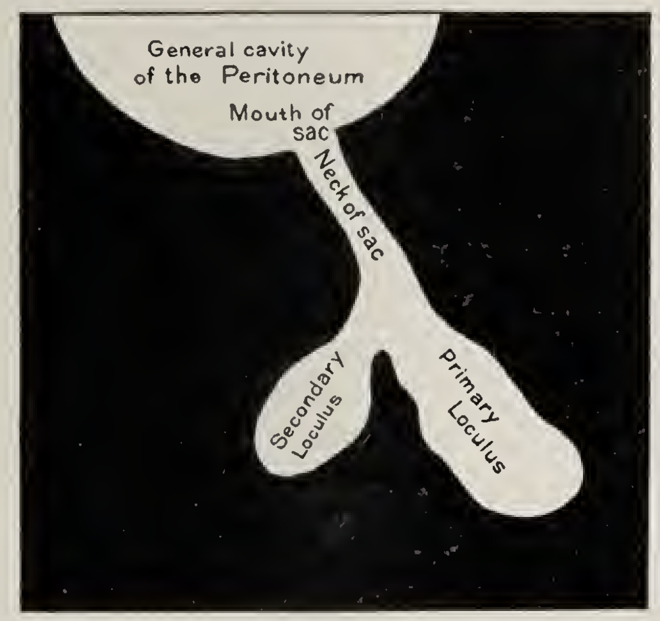

Fig. 500.—Bilocular Sac.

Contents of the Hernial Sac.—Any viscus of the abdomen except the pancreas may be found in a hernial sac. Hernias contain as a rule, however, both bowel and omentum. Of these, the long and mobile small intestine, and particularly the ileum, is most frequently found in the hernial sac. Next in order are found the transverse colon, the sigmoid flexure, and finally the cecum. The ascending and the descending colon are prevented from passing into the sac by their mesenteric attachments, except in connection with the sigmoid flexure or cecum. The vermiform appendix, Meckel's diverticulum (**Littré's hernia**), or an appendix epiploicae is occasionally found alone in the hernial sac.

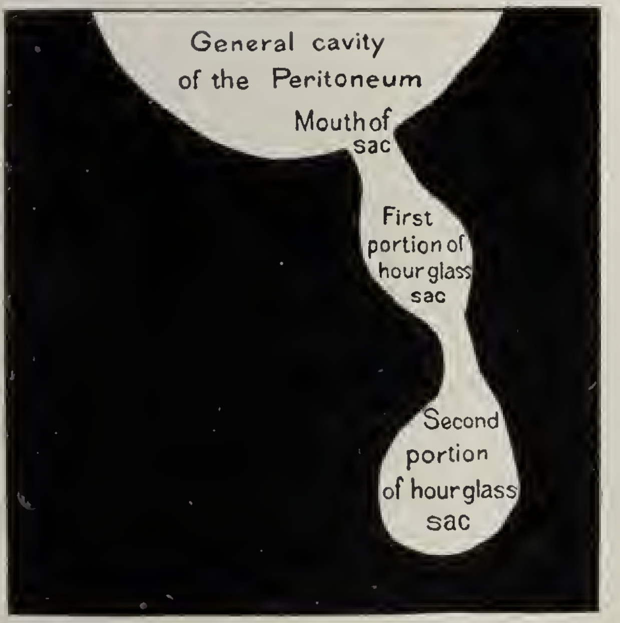

Fig. 501.—Hour-glass Contraction of Sac.

Enterocele is that variety of hernia in which intestine alone forms the contents of the sac. The swelling is distinctly elastic to the touch, with a tympanitic note on percussion. Gurgling is present on manipulation and reduction. The latter occurs suddenly.

Partial enterocele or **Richter's hernia** is that form of hernia in which only the free convex surface of a knuckle of intestine is found in the sac, the mesenteric attachments remaining in the abdominal cavity.

Epiplocele is the name given to a hernia containing omentum only. In this form the hernia is soft and doughy, no gurgling is present on reduction, and the percussion-note is dull. When both intestine and omentum are present, the hernia is called an **enteroepiplocele.** In children omentum is rarely found in the hernial sac except in the rare instances of a congenital epiplocele, on account of the shortness of this structure in early life. Both intestine and omentum are frequently found in inguinal hernia and occasionally in femoral hernia. Omentum alone occurs only infrequently in inguinal hernia and very rarely in femoral hernia.

The long-continued presence of omentum in a hernial sac leads to more or less extensive adhesions and considerable increase of its adipose tissue (lipoma). Lipomatous masses are found only in true enterocele when portions of colon form the contents of the hernial sac, these having their origin in hypertrophy of the epiploic appendages. Adhesions between intestines and the walls of a hernial sac are prevented by peristaltic movements of the former, except in cases of old hernia which have been subjected to external injuries.

The stomach has been found in diaphragmatic and umbilic hernias, the uterus (even in pregnancy) and an ovary and a floating kidney in ventral hernia, and the anterior wall of the bladder in vaginal hernia in connection with vesical calculus. The bladder wall has been dragged into the sac of an inguinal hernia by attached lipomatous masses. **Eventration** may occur in old and enormously large umbilic and inguinal hernias, the stomach and uterus and even a part of the liver finding their way into the hernial sac.

Fluids, either simple serum, as in simple irreducible hernia, or both blood and serum, as in strangulated hernia, may form part of the contents of a hernial sac.

Hydrocele of the hernial sac is said to be present when the latter becomes shut off from the general peritoneal cavity by adhesions, a plug of omentum, the vermiform appendix, or a Fallopian tube, and when fluid collects in the sac. In inflammatory conditions pus may be present. Fecal matter and gas are also found, in cases of perforation. Foreign bodies, such as biliary calculi and swallowed pieces of bone, may enter with fecal matter. **Fecal abscess** follows infection resulting from perforation.

Adhesions may form as the result of inflammation within the sac. These may be more or less dense and fibrous. They may occur in the shape of delicate threads, cordlike formations, or bands. The contents of the sac may become adherent to each other, the different portions of the hernial sac itself may adhere together, or adhesions may form between the contents and the sac walls. Adhesions may give rise to strangulation within the sac or they may prevent reduction by taxis. In cases in which long adhesions exist they may allow reduction, the contents remaining attached to the inner surface of the sac.

Hernias may be either **congenital** or **acquired.** The former are due to defects of development, while the latter occur independently of such defects except in the case of the defective conditions of the abdominal wall incident to the descent of the testicle. A hernia may make its first appearance after an accident or an injury. If, under these circumstances, it at once becomes strangulated, it may be deemed to be **traumatic** in origin.

Causes of Hernia in General.—Among the **predisposing causes** may be mentioned the following: (1) **Age.** As a general rule, hernia occurs most frequently during the active years of life, the frequency declining with advancing years. (2) **Sex.** On account of the greater activity of the male sex, the latter is more prone to hernia than the female sex, the proportion being about six to one. (3) **Conformation of the abdomen.** The presence of "bulging" in the median line and at the site of the oblique muscles

(Malgaigne) is said to favor the occurrence of hernia. (4) **Abnormal length of the mesentery.** (5) **Ptosis of the abdominal organs** or **Glénard's disease.** This will bring a portion of the small intestine nearer the hernial openings. It may occur particularly on the left side, owing to the fact that the fibromuscular expansion which supports the mesentery and which is elongated in this condition has its upper attachment to the diaphragm, to the left of the median line.

Among the **exciting causes of hernia in general** may be mentioned the following: (1) **Occupation.** Laborious occupations involving the lifting of heavy weights, and work performed particularly in the stooping position, lead to the occurrence of hernial protrusions. (2) **Pregnancy and parturition.** Hernias occur during pregnancy and parturition, particularly in women who have borne children at short intervals, in whom there has been insufficient time between the pregnancies for the abdominal coverings to regain their normal tonicity after the tension to which they have been subjected by the presence of the gravid uterus. Inguinal hernia may result from **increase in size of the round ligaments** during pregnancy, the recession of the ligaments at the termination of the pregnancy leaving an enlarged canal of Nuck into which a portion of intestine or omentum may subsequently find its way. Femoral hernias are still more frequent after pregnancy. On the other hand, a hernia may disappear or become smaller during the period of gestation. An umbilic hernia is more liable to develop during parturition. (3) **Increase of bulk of abdominal viscera** from deposits of fat in the omentum, or neoplasms. (4) **Coughing, crying in infants, straining at stool** or **during micturition, tight lacing,** and **ascites.**

CLINICAL CONDITIONS OF HERNIA

A hernia may be presented to the surgeon in one or more of the following conditions:

Reducible Hernia.—This term is applied to hernias in which the contents can be returned to the abdomen. This is usually possible before the formation of adhesions or in the absence of strangulation. The reduction may take place spontaneously when the horizontal position is assumed; or it may require the aid of taxis, the hernia returning with a peculiar gurgling sound and sensation in the case of an enterocele. The latter may continue to be reducible for a long time after its development. In epiplocele, or enteroepiplocele, adhesions form comparatively early and the hernia may then become irreducible. In addition to the reducibility of the hernia, this clinical condition is characterized by the following: (1) a soft and somewhat elastic swelling in one of the regions in which hernia occurs; (2) the presence of an expansile impulse on coughing or an increased protrusion on straining. There is likewise a sense of weakness present and more or less local discomfort, particularly when the protrusion occurs; tenderness is usually present in the neighborhood of the hernial ring.

In addition to the more or less pronounced symptoms of distress and discomfort incident to the passage of a hernial sac and its contents through the abdominal wall, these being particularly notable on exertion, **disturbances of digestion** may occur and proper defecation be interfered with. In cases of enterocele protrusion is accompanied by pain along the course of the mesenteric nerves toward the spinal column, and in epiplocele by pain in the direction of the attachment of the omentum at the transverse colon.

The **treatment** of reducible hernia embraces the palliative or mechanic appliances designed to restrain the contents of the abdominal cavity within the hernial orifice, and operative measures for radical cure. The mechanic appliances, known as **trusses,** in order to accomplish their object must retain the hernia completely without giving rise to discomfort to the patient. The apparatus should consist of a steel spring which surrounds the pelvis entirely, or nearly so, on which is placed a pad through which pressure is made at the hernial orifice by the spring to retain the hernia. The so-called water pad gives the most general satisfaction. The truss should be applied with the patient in the horizontal position (except in cases of incomplete hernia, when this is not so important) and with the contents of the hernia completely reduced. In adults the truss may be discarded at night, but in infants and young children it should be worn day and night. The skin beneath the pad should be frequently bathed with alcohol in order to prevent excoriations. The length of time that a truss should be worn will depend on the age of the patient and the size of the hernia. A certain proportion of infants and children are cured by trusses if the treatment is properly and faithfully carried out. After puberty cures are exceptional. In infants one year old the truss should be worn at least a year after the last appearance of the hernia. In older children at least double this length of time should elapse and in young adults the time should be still further lengthened. In the case of a hernia present at the twentieth year a truss should be worn permanently, or an operation for radical cure should be undergone. Where a truss fails to retain the hernia, the choice lies between radical operation and the use of a suspensory or sling. In large scrotal hernias, with orifices large enough to admit four fingers, occurring in middle-aged or elderly persons, the latter is the only resource.

Radical operative interference is indicated in reducible hernia in children (1) in cases complicated with hydrocele; (2) in cases in which, for any reason, successful mechanic treatment cannot be carried out; (3) in cases of hernia occurring in children over four years of age in which mechanic treatment has failed to effect a cure; (4) in the rare cases of femoral hernia occurring in children. These indications refer to inguinal and femoral hernias. Umbilic hernia in children rarely requires operative treatment, cure being usually possible by properly applied mechanic support if this does not occur spontaneously. In otherwise healthy adults radical operation is advisable in reducible hernia (1) in all patients over twenty years of age, and even in some who are much younger, inasmuch as in the first named cure by truss is rare and in those between fifteen and twenty it is exceptional; (2) in all cases of femoral hernia, unless some contraindication exists.

A truss should not be worn after a successful operation for the radical cure of hernia, except in exceptional instances, to be mentioned later.

Irreducible Hernia.—This is a hernia in which the contents of the sac cannot be returned to the abdominal cavity. A portion of the contents may be reducible and the remainder irreducible. The irreducibility may be temporary or permanent. **Simple irreducibility** involves neither inflammation, strangulation, nor interference with blood-supply, though an irreducible hernia may be complicated with any one of these.

The **predisposing causes** of irreducibility are as follows: (1) **Age.** An irreducible hernia is very infrequent in children on account of the absence of omentum and the rare occurrence of adhesions in a hernia containing intestine only. An irreducible hernia in a child is usually a congenital cecal hernia, adhesions forming between the portion uncovered by peritoneum and the sac. (2) **Sex,** and **variety of hernia.** Females are more commonly the subjects of femoral hernia, and, inasmuch as this variety is irreducible about ten times more frequently than the inguinal, so that about 15 per cent of all femoral hernias become at one time or another irreducible, females may be said to have irreducible hernia more frequently than males. Umbilic hernia is next most frequently liable to become irreducible, and lastly inguinal. (3) **Neglect.** Habitual carelessness as to the condition of the hernia favors irreducibility, particularly the wearing of improperly fitted trusses. In addition a laborious occupation and the inability to retain the hernia by any form of truss may be included among the predisposing causes.

The **exciting causes** of irreducibility include the following: (1) **Contraction of the tissues about the hernial sac.** (2) **Thickening and contraction of the neck of the sac,** due to the irritation of truss pressure, and **hour-glass contraction** of the sac. This is particularly true in double hour-glass contraction. (3) **Increase in the bulk of the contents of the sac,** *e. g.*, in the omentum and mesentery from deposits of fat and in the mesenteric glands within the sac from tuberculous disease. (4) **Adhesions.** While these may at times be sufficiently stretched to permit reduction of the hernial contents of the sac, the reduction is not free from danger under these circumstances, subsequent intestinal obstruction occurring. Those occurring between the hernial contents and the sac wall, particularly in the case of epiplocele, the omentum being more frequently implicated than the intestine, are most liable to cause irreducibility. (5) **Contraction of the abdominal cavity.** This results from long-continued protrusion of a considerable portion of the abdominal viscera and will prevent reduction of the hernia.

Next to omentum portions of the large intestine are the most common **contents of an irreducible hernia,** particularly in cases of old umbilic hernia. The occurrence of irreducibility in a congenital cecal hernia has already been referred to (*vide supra*). The presence of the bladder or of an ovary in a hernia is quite commonly followed by irreducibility. Finally, fluid may accumulate in the sac of an irreducible hernia.

The **symptoms of an irreducible hernia** relate to the presence of a swelling in a hernial region which presents a distinct impulse on coughing and which does not disappear spontaneously when the horizontal position is assumed, or gentle taxis is employed. In small irreducible hernias there may be no other symptoms. In large protrusions, however, the dragging of the omentum on the viscera to which it is attached (stomach and transverse colon) may give rise to colicky pains, symptoms resembling intestinal obstruction, or even those of strangulation. Constipation is usually present. An irreducible hernia is specially liable to injuries which, together with truss-pressure, are liable to set up inflammatory changes.

The **prognosis** in an irreducible hernia is more serious than in a reducible one, on account of the liability to inflammation, obstruction or incarceration, and strangulation. The dangers of strangulation are particularly great in young subjects, in whom an irreducible hernia is liable to be a pure enterocele. Fortunately, however, irreducibility in the latter is rare.

The **general measures of treatment** in irreducible hernia include rest in the recumbent position and the application of an ice-bag, the proper use of taxis, and, finally, these failing, herniotomy, to which may be added, in properly selected cases, an operation for radical cure. In applying the ice-bag, the latter should not rest directly on the skin. **Gentle taxis** should be applied from time to time during the treatment. This should be limited to a few minutes' trial. Small irreducible epiplocele which persists as such may be treated in exceptional cases by means of truss pressure, but the majority of cases of irreducible hernia should be subjected to herniotomy. Patients under fifty years of age who have irreducible hernias not larger than the two fists, but who are otherwise healthy, should be subjected to the operation for radical cure.

Reduction en masse, the detached sac with its contents being forced into the subperitoneal connective tissue (Fig. 502), as well as **rupture of the sac** or **injury of the intestine,** may occur from attempts at reduction. Lipomatous proliferation in herniated omentum always demands extirpation before reduction can be accomplished. It is in this class of cases that strangulation occurs the most readily. The radical operation should always be added to the operation for extirpation of lipomatous masses unless some direct contraindication exists, such, for instance, as a contracted abdominal cavity, the presence of an extremely large point of exit of the hernia, etc., conditions frequently found in old persons. Here the application of a properly adjusted suspensory bandage will ameliorate the condition.

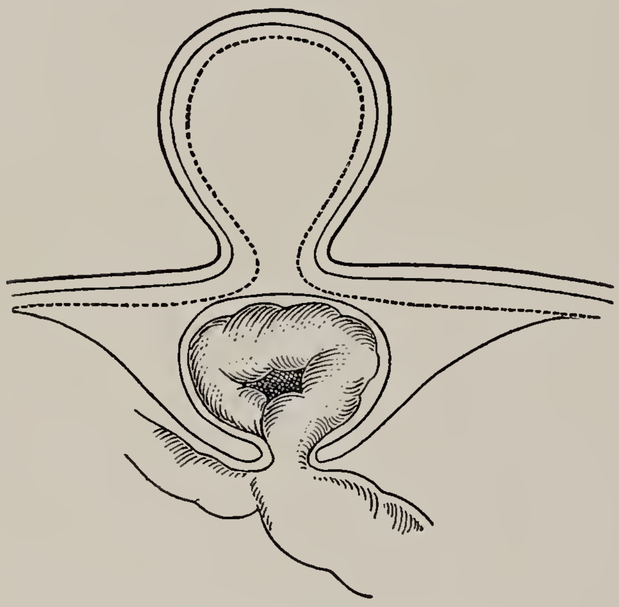

Fig. 502.—Reduction en masse.

Taxis, or reduction of a hernia by pressure with the fingers, is effected with the patient in the horizontal position and the lower limbs straight. In the case of inguinal or femoral hernia the surgeon stands or sits by the patient's side. The direction in which the pressure is to be made varies with the form of hernia. The tumor is first grasped with the right hand and drawn down slightly and the neck of the sac steadied with the thumb and finger of the left hand. The thumb and spread-out fingers of the hand grasping the tumor direct the contents of the sac toward the hernial opening, the pressure employed being as uniform as possible and exerted alike by the fingers and the palm of the hand. The portion of the hernia which escaped last must be made to reenter the orifice first. As a rule, this will be found to lie at the posterior portion of the sac. If any omentum is present, it generally lies anteriorly and should be reduced last. Large hernial protrusions will require the use of both hands, while in very small hernia only the tips of the fingers will be brought into use. In femoral hernia flexure and inward rotation of the thigh may assist in the reduction. In inguinal hernia the pressure should first be directed upward, then upward and backward, and finally backward; in femoral hernia it should be first downward and then backward and upward; in umbilic hernia the pressure is to be made directly backward. *Excessive force should never be used and the duration of the attempt at reduction by taxis should not be longer than five minutes. Taxis should never be employed in cases of indubitable strangulation.* Successful reduction is announced by the complete disappearance of the tumor. This will occur suddenly in enterocele and gradually in epiplocele. The reduction should be verified by passing the finger into the canal, which should be found empty. In cases of large hernias which have been unreduced for a long time some pain may be experienced when the reduction takes place.

The administration of an anesthetic will be of assistance in producing muscular relaxation, as well as in mitigating the patient's suffering. Before administering an anesthetic the surgeon should make every preparation to operate. For indications and contraindications in the use of taxis and the dangers attending its employment, see page 155.

Inflamed Hernia.—Inflammation may attack the hernial sac, the contents of the sac, or both. Of the contents of the sac the omentum is most liable to inflammation. Inflammation occurs most frequently in femoral hernia. Next in frequency it occurs in umbilic hernia. Inguinal hernias are the least frequently inflamed. **The causes of acute inflammation of a hernia** are (1) external injury; (2) acute strangulation; (3) extension of inflammation from enteritis. Chronic inflammation may result from tuberculous peritonitis and neoplasms. All forms of inflammation may lead to the formation of adhesions.

The **symptoms** of an acutely inflamed hernia are redness of the overlying skin, increase in the size of the swelling, edema, pain and tenderness, and, in some cases, increased tension due to the presence of fluid. The inflammation is usually limited to the hernia and its skin coverings, though it may spread to the peritoneal cavity.

The **prognosis** in inflamed hernia is favorable in young and middle-aged subjects and unfavorable in the aged. The most serious incident in connection with its occurrence in reducible hernia is, as a rule, the formation of adhesions with its sequels of irreducibility leading to subsequent attacks of inflammation and strangulation.

The **treatment** of an inflamed hernia includes rest in the horizontal position, free purgation, and either hot or cold applications to the inflamed parts. Cold should be tried first, and if it relieves the patient it should be continued. Otherwise hot compresses should be used. Persistency of the inflammation and the occurrence of suppuration are indications for exploratory incision.

Incarcerated or Obstructed Hernia.—A hernia is said to be incarcerated or obstructed when its lumen is obstructed from within. This is most common in irreducible hernia and is usually due to the presence of firm feces. Rarely it arises from intestinal gas, foreign bodies, or undigested food. Incarceration occurs most frequently in umbilic hernia, owing to the presence of the large intestine. Irreducible inguinal hernias, particularly those of large size, which contain either the cecum or the sigmoid flexure, are next most frequently the seat of an incarceration. Incarceration may also occur in reducible hernias.

The **symptoms** of incarcerated hernia vary in severity. In the milder cases the symptoms are due to simple constipation, and difficulty is experienced in definitely locating the cause in the hernia. In the more severe cases the condition may be mistaken for strangulated hernia. The gradual development of the symptoms is the main point in the differentiation. The pain and tenderness are but slight, as a rule. There is increase in the size of the irreducible hernial swelling. The latter is "doughy" to the feel, and dull on percussion unless flatus is present. The expansile character of the impulse on coughing may be diminished but it is not lost altogether. The constipation is not usually complete. While vomiting is present in some cases, this is neither urgent, persistent, nor stercoraceous. Symptoms of disturbed digestion, such as anorexia with coated tongue, foul breath and eructations, are present. If the incarceration persists, the abdomen becomes tense and intestinal colic ensues. Finally, the constitutional disturbance is slight, there is no collapse, and the "facies abdominalis" is absent.

The **prognosis** in incarcerated hernia is favorable except in the aged. The symptoms rapidly disappear as soon as free bowel movements are obtained. The greatest danger incident to this condition is the supervention of strangulation.

The **treatment** consists of the usual measures for overcoming obstinate constipation, with the exception that the use of a cathartic should be withheld until copious enemas have cleared out the lower bowel. Kneading, to empty the bowel within the sac of its contents, and gentle taxis have effected reduction. If these measures are not efficient, and if, with increasing distention and pain, vomiting becomes more frequent and the constipation absolute, the case should be treated as one of strangulation, and herniotomy resorted to. Care in regard to diet, the patient selecting only such food as will leave, when digested, the minimum of waste material, and attention to daily evacuation of the bowels are proper measures in preventing recurrence.

Strangulated Hernia.—Strangulated hernia may be defined as an irreducible hernia in which a loop of intestine is so constricted from without as to prevent the passage of its fecal contents and to interfere with its circulation. An irreducible omental hernia in which the vessels of the omentum are constricted sufficiently to produce strangulation is rare. All hernias which contain intestine are liable to strangulation, due to more or less compression made on the part of the bowel lodged in the mouth of the sac, by the comparatively unyielding external tissues. When this occurs to the extent of interfering with the return circulation alone, the arteries continuing to convey blood to the loop, venous engorgement ensues. This is followed by infiltration of the tissues of the bowel walls, as well as by exudation of serum into the hernial sac. The bowel walls become thickened, the pressure being thereby increased. Interference with the function of the intestine resulting from the disturbances of circulation gives rise to the development of gas within the lumen of the intestine, whereby the pressure is still further increased. **Gangrene** may follow at varying intervals, depending on the amount of pressure exercised by the constriction.

The strangulation is usually directly due to the combined effects of elastic constriction at the neck of the sac and fecal occlusion. Inflammation or engorgement of the contents of the sac, or adhesions found between the sac and its contents, often lead to strangulation in irreducible hernia.

Strangulation occurs more frequently in femoral than in inguinal hernia. Of 276 cases of strangulated hernia, 57.6 per cent were of the femoral variety, as compared with 40.2 per cent of the inguinal variety (Henggeler).

The more important general **symptoms** of strangulated hernia include pain, vomiting, absolute constipation, prostration, and finally collapse. The pain occurs in colicky or griping exacerbations and is referred to the umbilicus. In the intervals of the paroxysms of griping pain there is a continuous dull ache, which, of itself, may occur in exacerbations. If gangrene supervenes, the pains cease. **Vomiting** is the most important of the symptoms of strangulation. The vomited material consists at first of the undigested contents of the stomach. Then follow mucus and bile, and finally intestinal contents (**stercoraceous vomiting**). The vomiting is persistent, unaccompanied by marked nausea, "gushing" in character, and noticeable for the large amounts ejected. In the beginning it is reflex through stimulation of the abdominal sympathetic plexuses. Later on it is due to a reversed or upward axial stream (Fig. 503). Finally, it may be the result of stimulation of the vomiting center in the medulla by septic products. The vomiting may cease after the bowel has been for a long time imprisoned or when gangrene supervenes. When the constriction is low down, the stercoraceous vomiting is correspondingly delayed. It is rarely absent, even in cases of strangulated partial enterocele or Richter's hernia. In many cases the **constipation** is not absolute at first, the portion of intestine below the point of strangulation frequently emptying itself of its contents after the use of enemas when strangulation has taken place. Thereafter, however, neither fecal matter nor gas is expelled. The **prostration** varies greatly but is rarely absent. Its severity and time of appearance are proportionate to the acuteness and degree of the constriction and the youth or the feebleness of the subject. It is characterized by languor, with anxious and drawn or pinched countenance and sunken cheeks (**facies abdominalis**). The tongue may become dry and coated (**the typhoid condition**). The prostration is increased by efforts at taxis. **Collapse** is manifested by perspiration, cold and livid extremities, shallow breathing, and a weak and small pulse. In late cases the absorption of toxic products from the paralyzed intestine may lead to a persistence of the symptoms, even though the strangulation is relieved.

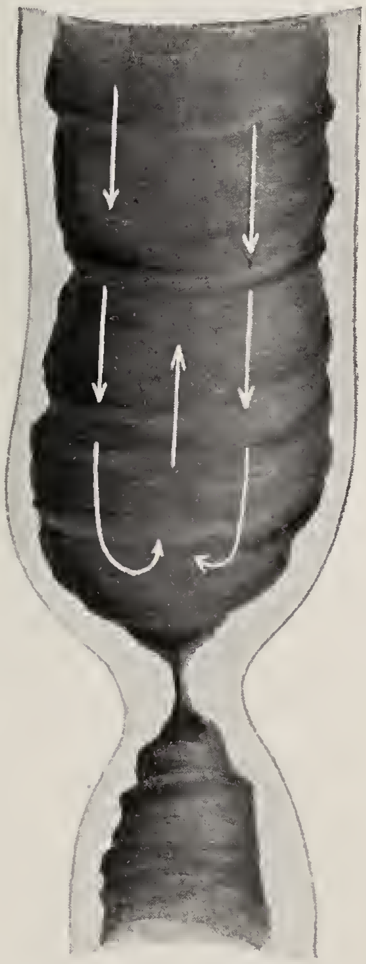

FIG. 503.—PERIPHERAL AND AXIAL STREAMS IN A CONSTRICTED LOOP OF BOWEL.

The arrows pointing downward show the normal stream directed against the constriction. The arrow pointing upward shows the reversed or upward axial stream (adapted from Eccles).

Other general symptoms are as follows: Slight alteration of temperature in early cases, and a subnormal temperature in late cases, increased pulse-rate, intense thirst, diminution of the secretion of urine, tympanites, particularly if the obstruction is low down, and eructations and hiccough. When the patient is *in extremis*, there will be general tremors, convulsive movements, muscular cramps, delirium, and coma.

The **local symptoms** of strangulated hernia embrace irreducibility, increase in size and tension of the protrusion with lessening or loss of impulse, fluctuation in the hernial sac, and absence of gurgling sounds. The sign **irreducibility** is of considerable value from the fact that a large number of hernias which become strangulated were previously reducible. If the hernia has been previously in existence, or irreducibility has been present, an increase in the size of the protrusion will be noted. This may be due in part to an increased amount of viscus protruded, to infiltration and swelling of the tissues of the hernial contents, to fluid in the hernial sac, and perhaps to inflation of the herniated loop of intestine by gas within its lumen. The entire swelling may be small and insignificant. **Increase of tension** is present in the majority of cases and is due mainly to the accumulation of fluid in the hernial sac. Expansile impulse on coughing, characteristic of simple reducible hernia, is lost, the forward impulse present in other parts of the abdominal wall being alone noticeable. In cases in which the accumulation of fluid is sufficient and the tenseness of the sac not too great, **fluctuation** will be present. **Absence of the gurgling sounds** normally present and demonstrable with the stethoscope is a sign that should be taken advantage of in the diagnosis of strangulated hernia. The percussion-note may be dull or tympanitic, this depending on the presence or absence of fluid in the sac.

The Diagnosis of Strangulated Hernia.—In the majority of cases the combined presence of an irreducible hernia and symptoms of intestinal obstruction suffices for the diagnosis. Exceptionally, however, the symptoms and signs may be incomplete, as, for instance, in cases of partial enterocele (Richter's hernia), strangulation of a Meckel's diverticulum (Littré's hernia), or strangulation of the vermiform appendix. Again, symptoms of intestinal obstruction may arise from strangulation of intestine within the sac due to bands of adhesions and slits in the mesentery, as well as from angulation, or from axial twists or volvulus. Further, the diagnosis may be obscured by loculated and pouched sacs, or by the presence of two or more hernias, the one concealing the other, or the one irreducible and the other strangulated. Finally, the symptoms may be due to intestinal obstruction within the abdomen in a patient with an irreducible hernia.

The **differential diagnosis** of a strangulated enterocele or enteroepiplocele from other conditions which may simulate it will embrace a consideration of such changed conditions of an existing hernia as strangulation of omentum, incarceration, inflamed hernia, and the strangulation of the contents of a hernial sac other than intestine, such, for instance, as an ovary, the bladder, etc. Further, some of the general symptoms of strangulated hernia may be simulated in a patient with a hernia by peritonitis or enteritis, the persistent vomiting of pregnancy or severe colic; and the local symptoms by inflamed lymphatic glands, or acute orchitis or epididymitis.

The Pathologic Conditions Found in a Strangulated Hernia.—Of the effects produced by strangulation, the most important are those which relate to the **intestine.** The latter may be found in a condition of inflammation, due to infection, ulceration as a result of the inflammation, or gangrene from interference with the circulation and septic infection of the tissues of the bowel. The **omentum** may suffer but slight if any change, aside from the inflammatory conditions occurring in connection with the strangulated loop or bowel. In rare cases septic infection may take place from a bowel loop that is the seat of advanced destructive changes. With the exception of the changes in the vessels of the mesentery (phlebitis and thrombophlebitis), the latter is simply congested and ecchymotic. The **sac wall** may be the seat of severe inflammation, with subsequent tissue changes which may render it liable to rupture on the application of improper taxis. The **coverings of the hernia** may take part in inflammatory conditions which arise in the hernia itself; they may be injured by attempts at taxis, or they may become the seat of gangrene independent of gangrene of the hernia. The effects on the **general peritoneal cavity** are next in importance to those on the intestine and have a direct pathologic connection with them. Paralysis of the muscular wall of the bowel extends to the portion within the peritoneal cavity, and this, together with nutritive changes of the bowel wall, permits bacterial infection which may lead to either localized or general **septic peritonitis.** The latter may also occur after reduction by taxis, either from infection from septic contents of the hernial sac, from an inflamed loop of bowel, or from infection from intestinal contents through a perforation of the gut.

The Treatment of Strangulated Hernia.—The dangers incident to a strangulated hernia are such as to demand prompt operative interference. In indubitable cases the question of reduction by taxis should not be entertained for a moment, for the following reasons: (1) inflammatory conditions, or even gangrene of the contents, may be present; (2) in strangulation occurring in a previously irreducible hernia extensive adhesions are probably present, exposing the patient to the dangers of reduction *en masse;* (3) when the strangulation has existed for several hours (and the great majority of patients do not come under the surgeon's care before this time), there is danger of forcing septic contents into the general peritoneal cavity, or even of replacing gut the seat of an actual or impending perforation; (4) the patient's general condition may be such that the additional prostration resulting from attempts at reduction by taxis may be a much more dangerous element in the case than an immediate herniotomy; (5) the dangers of bruising or lacerating or even completely rupturing the intestinal wall constitute positive contraindications to the employment of taxis, except in cases in which opportunity is afforded for its employment almost immediately after the occurrence of the strangulation, manifestly a very rare circumstance.*

If reduction has been effected by taxis, the symptoms may persist by reason of (1) reduction *en masse;* (2) an internal strangulation, *i. e.,* within the sac; (3) hour-glass contraction of the sac and reduction of the contents of the outer compartment into the inner; (4) the pressure of a previously undiscovered second hernia. In all of these the incision may be made at the site of the hernia. In all cases of infection of the peritoneal cavity following reduction by taxis, median abdominal section will be demanded, since this infection may be due to gangrene, or to subsequent perforation of the gut.

The Treatment of Strangulated Hernia by Herniotomy.—The preoperative preparation of the patient will be necessarily hurried, since herniotomy for strangulated hernia is *par excellence* an emergency operation. The aseptic cleansing should be commenced as soon as the decision to operate has been arrived at and should even precede the administration of the anesthetic for the purposes of taxis, in the rare cases in which trial of the latter is considered advisable.

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* The mortality following reduction of strangulated hernia by taxis is 14.9 per cent in femoral hernia, and 7.8 per cent in inguinal hernia (Frikhoffer).

A general anesthetic is desirable, but local or spinal cocainization may be substituted if necessary. The line of incision will vary with the form of hernia. The superficial incision should be free. It is not necessary to differentiate accurately the deeper layers in the dissection until the sac is reached. The bluish color of the latter when fluid is present, will aid in the recognition. Its so-called arborescent vessels are not often apparent. The contents may be visible through an attenuated sac wall. In case of doubt the final incision should be made obliquely. The escape of a small quantity of fluid takes place when the sac is opened. The sac should always be opened in order that its contents may be inspected before reduction. If fluid is present, it should be wiped away with sterile gauze as it flows from the small opening first made. The constricting bands are divided **from without inward,** except in rare cases in which the constriction is felt by the finger to be in a situation where division from without will considerably damage the overlying parts, as in certain cases of femoral hernia. In dividing the constriction from without inward, the tip of the left index-finger is insinuated beneath the margin of the hernial orifice and the division made by short nicks of the edges of the opening, the finger being used to prevent injury to the gut. In dividing from within outward, the hernia bistoury (Cooper) is first laid flat and introduced along the finger and then turned edgewise and the stricture divided by gentle sawing movements. If the finger cannot be introduced, the grooved director may be used, but this adds an additional element of danger to the operation from injury to the intestine, the latter curling up and overlapping the director. Stretching or dilatation of the hernial orifice is scarcely feasible. The contents of the sac should be drawn down as soon as released and the amount of damage inflicted at the site of the constriction estimated. If there is any omentum in the sac, it is to be tied off in sections and the part beyond the ligature removed. In order to lessen as much as possible the risks of intestinal obstruction following adhesions between an adjacent coil of intestine and the cut surface of the omentum, the latter is rolled under or turned in so that the raw surface is no longer exposed but rests on the remainder of the omentum, where it is secured by a few sutures. The utmost importance is to be attached to the treatment of the intestine itself. The latter may be damaged but still capable of resuming its function, or its vitality may be so seriously impaired as to preclude hope of its recovery. There is a third class of cases in which doubt exists as to whether or not the bowel should be returned to the abdomen. If the color of the intestine is black, or nearly so, it should not be returned; either an immediate resection and end-to-end enterorrhaphy should be made, or the damaged intestine should be left in the sac after the constriction is divided (*vide infra*). If bowel is returned the condition of which is at all doubtful, it should be placed as nearly adjacent to the wound as possible in order to facilitate the exit of its contents should the bowel wall subsequently give way, and in closing the wound a gauze drainage strip, or a soft rubber drainage-tube should be placed *in situ,* as a measure of safety. If, owing to the thickening of the bowel wall, the reduction is not easily accomplished, the hernial orifice is to be still further enlarged. Forcible crowding of the extruded mass against the edges of the opening may inflict serious damage on the bowel. The surgeon must make certain that the entire contents of the sac have been completely returned within the abdomen, by following up the reduction with his finger. At the same time he should determine the presence or absence of any constricting bands about the neck of the sac, in which situation such adhesions are likely to exist.

If the bowel loop is returned intact and the patient's condition will permit it, the subsequent steps of the operation should be those of one or another of the procedures designed for the radical cure of the hernia. In cases requiring resection of the bowel, operation for radical cure is precluded by the increased risks encountered in the average case, as well as by the probable subsequent occurrence of septic conditions in the wound.

In the **after-treatment,** the first and most important object is to combat shock by hot saline solution and whisky *per rectum,* elevation of the foot of the bed, hot bottles to the extremities, and the hypodermic use of strychnin. The diet for the first few days should be light but nutritious. If the bowels do not act spontaneously by the third, or, at the latest, the fourth day, an enema should be administered.

When the bowel is the seat of indubitable gangrene, there are three courses open to the surgeon: (1) simple incision of the gangrenous gut *in situ,* the constriction being left undisturbed, an artificial anus resulting; (2) the removal of the gangrenous portion after dividing the constriction and drawing down the strangulated loop, followed by the establishment of an artificial anus; (3) resection of the bowel for the removal of the gangrenous portion, and immediate enterorrhaphy. In the most desperate cases the first must be resorted to, though it is open to the objections that the gangrenous portion may extend within the peritoneal cavity and that the constriction may be sufficiently tight to prevent free fecal discharge. There is likewise a risk, in cases in which gangrene has rapidly supervened, that definite adhesions have not formed about the hernial opening, in which case the gangrenous bowel may slip back into the peritoneal cavity and fecal extravasation ensue. A compromise between this rapid yet somewhat dangerous course and resection and enterorrhaphy, the time occupied in performing which constitutes a very serious objection to their employment in many cases, is to draw down the gut carefully, after division of the constriction and removal of the gangrenous parts, and suture the two open ends in the wound. In case of recovery the resulting artificial anus can be dealt with subsequently, or provision may be made for its early and spontaneous closure by drawing out a sufficient amount of both the efferent and the afferent portion of the gut to permit the application of an elastic ligature between these (McGraw). The ligature is led through the entire thickness of the wall of adjacent portions of the bowel, which includes a space of about 2½ inches, and is tied tightly. A row of Lembert sutures is placed so as to unite the opposing serous surfaces of the bowel. In a few days the ligature cuts its way through, thus establishing an anastomosis between the efferent and the afferent portion of the intestine at the site of what constitutes the "spur" of an artificial anus. The subsequent operative and sometimes spontaneous closure of the artificial anus is thus greatly facilitated.

INGUINAL HERNIA

Inguinal hernia consists in the protrusion of a hernial sac containing intestine or omentum, or both, through either of the openings in the musculotendinous structures of the abdominal wall in the inguinal region made necessary in providing for the descent of the testicle during fetal life from its original position behind the peritoneum.

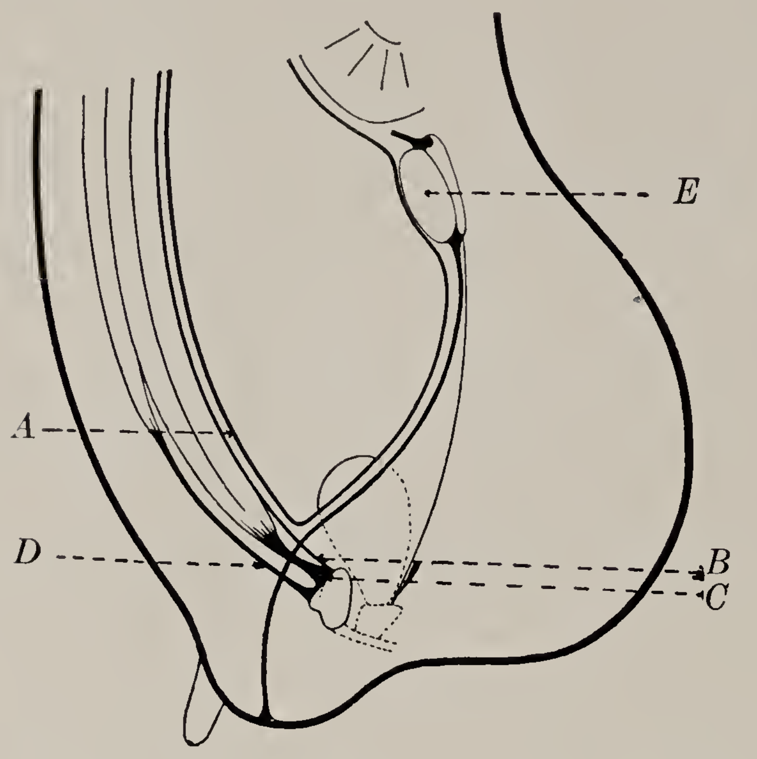

Fig. 504.—Testicle in the Lumbar Region (Fifth Month).

A, Peritoneum; *B*, transversalis fascia; *C*, conjoined tendon; *D*, aponeurosis of the external oblique; *E*, testicle.

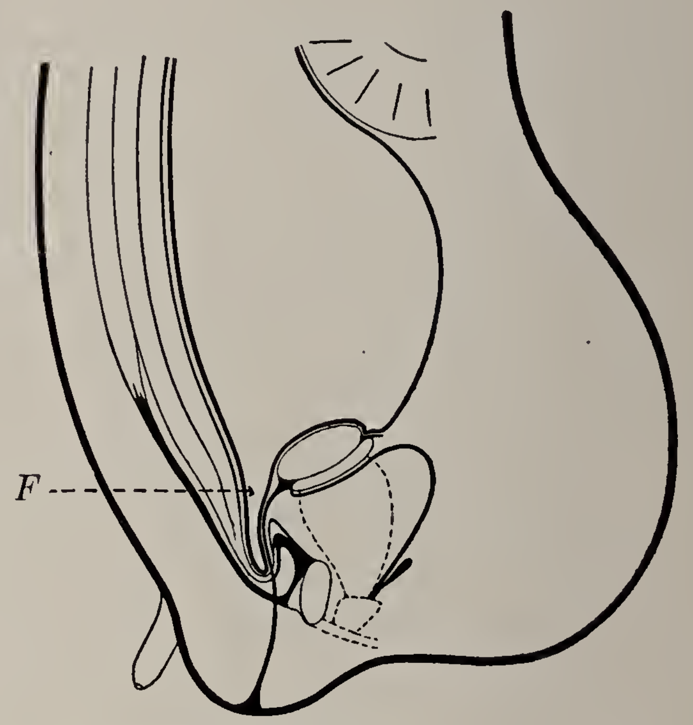

Fig. 505.—Testicle at the Internal Ring (Seventh Month).

Formation of the vaginal process. *F*, Vaginal process.

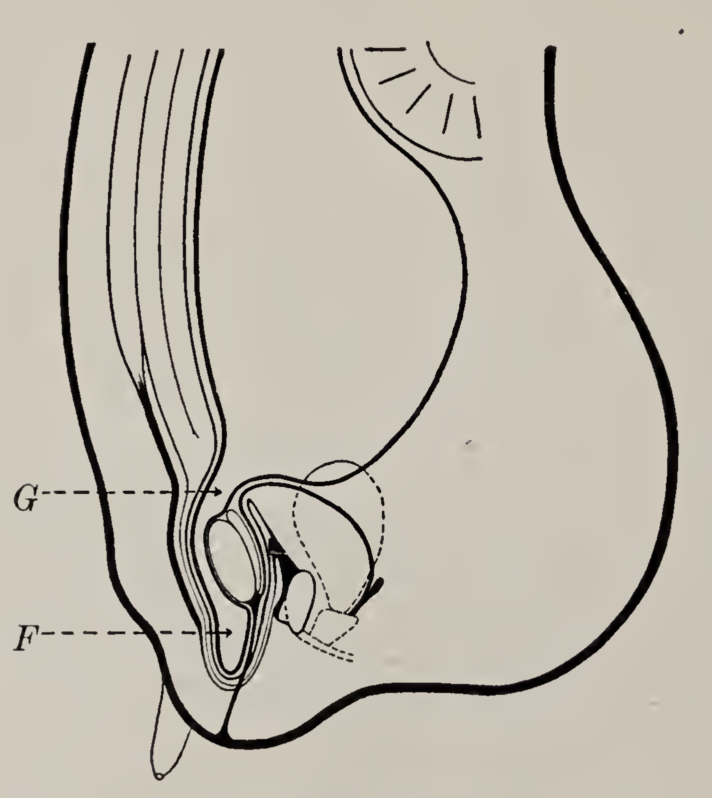

Fig. 506.—Testicle at the External Ring (Eighth Month).

F, Vaginal process; *G*, funicular process.

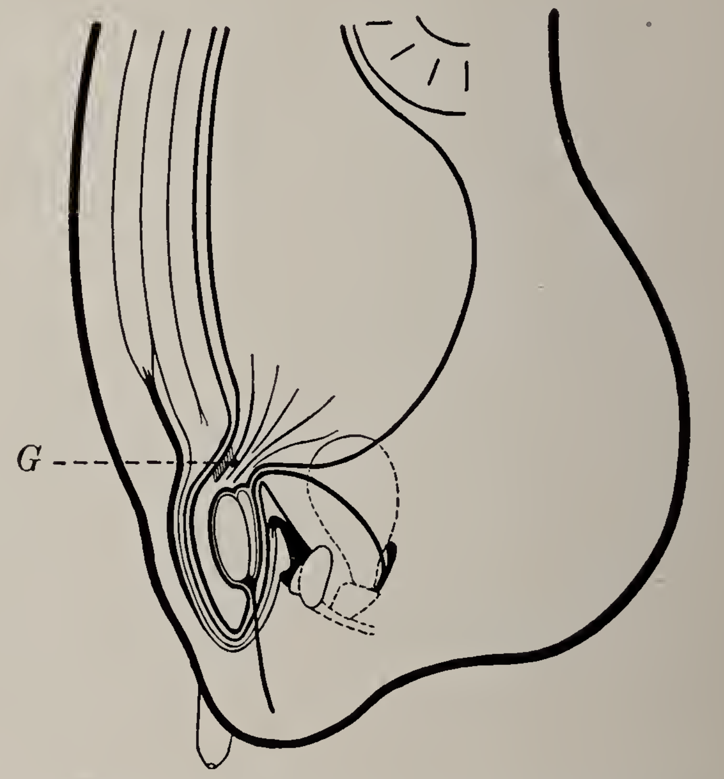

Fig. 507.—"Puckering" of the Peritoneum at the Internal Ring and Obliteration of the Funicular Process by Adhesion.

G, Folds and adhesions at the internal ring.

The Descent of the Testicle.

Congenital Inguinal Hernias.—The following points in the process of the **descent of the testicle** will serve to show the influence of the latter in the etiology of congenital hernia, as well as of inguinal hernia in general:

In early fetal life the testicle is covered in front and on the sides with the posterior layer of the peritoneum. At about the third month a peculiar structure, the **gubernaculum testis,** makes its appearance as a slender band, which extends from the groin through the inguinal canal to the testicle. The peritoneum, which up to this time has only partially invested the testicle, now incloses it and the gubernaculum, thus forming a mesentery. This process of the peritoneum, called the **mesorchium,** terminates below at the internal ring by a sort of tube, which is known as the **vaginal process** of the peritoneum. This tubelike projection of the peritoneum gradually protrudes itself into the inguinal canal, carrying with it the gubernaculum, until the latter forms a cordlike process which passes from the testicle to the bottom of the scrotum and is believed to become eventually the cremaster, reinforced, perhaps, by some fibers from the lower border of the internal oblique in its descent.

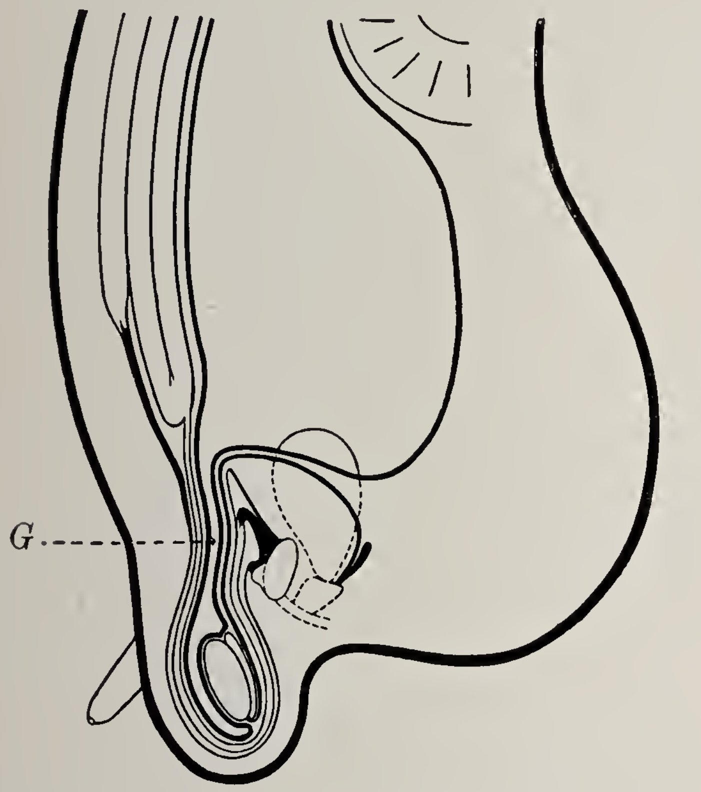

Fig. 508.—Funicular Process Remaining Patent Throughout.

Congenital inguinal hernia. *G*, Open funicular process.

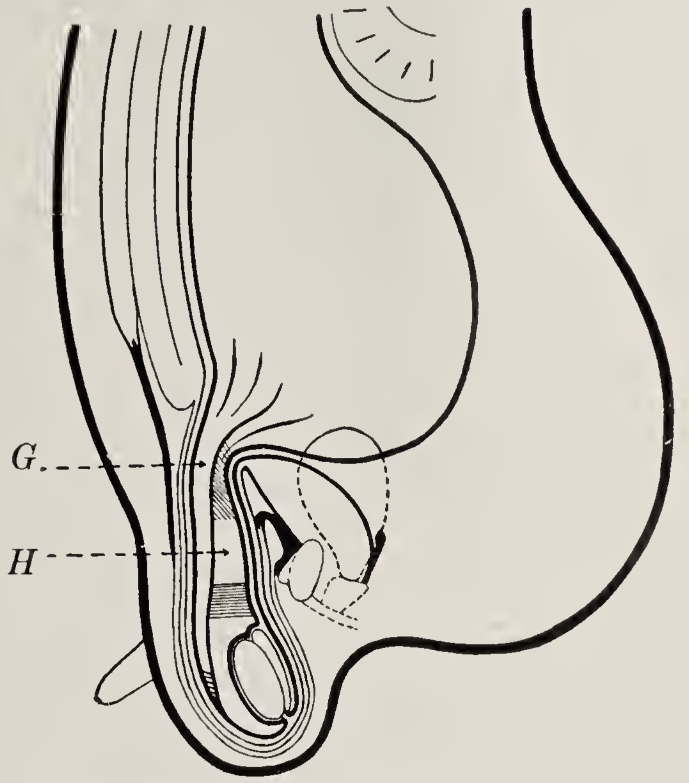

Fig. 509.—Partial Obliteration of the Funicular Process.

Adhesions in the canal and above the testicle, leaving space between (hydrocele of the cord). *H*, Hydrocele of the cord; *G*, part of the funicular process remaining open.

The Descent of the Testicle—(*Continued*).

From the fact that the body grows more rapidly at its upper part than at its lower part, and from the additional circumstance that the growth of the gubernaculum is not commensurate with that of the other parts, it necessarily follows that the testicle, being thus held fast to the bottom of the scrotum and thereby prevented from rising with the growth of the body, is drawn into the inguinal canal and finally, at about the eighth month, into the scrotum. During all this time the tubelike projection of the peritoneum, the vaginal process, which has preceded the testicle in the scrotum, remains open above and communicates by its upper extremity with the peritoneal cavity. Just before birth a process of obliteration commences at the point of communication with the peritoneal cavity which closes the latter and extends downward to within a short distance of the testicle itself. That portion which remains unobliterated becomes a closed serous cavity embracing the testicle and is known as the **tunica vaginalis.** The changes leading up to the final formation of the tunica vaginalis and the constricted portion of this structure, known as the **funicular process,** are shown in figures 505, 506, and 507.

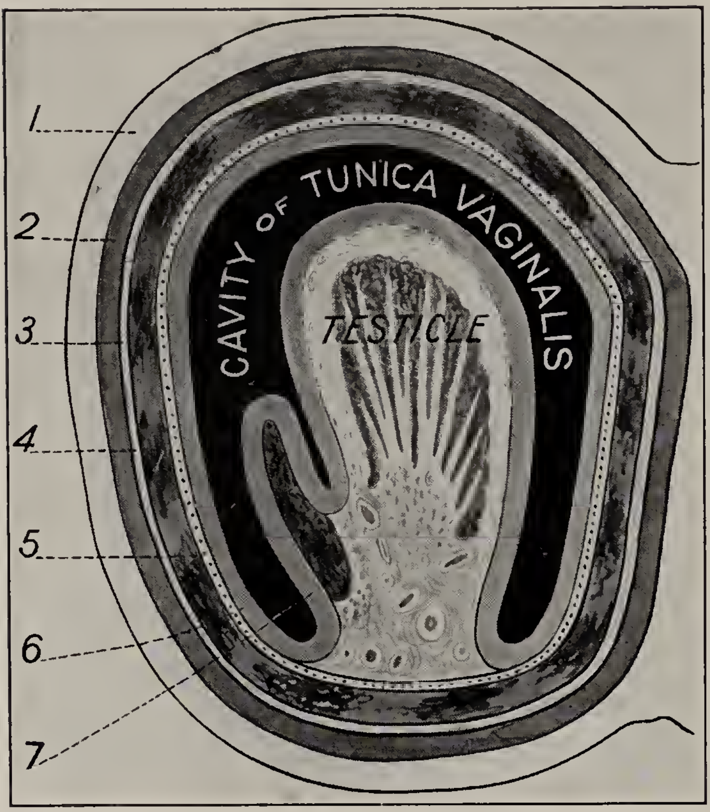

Fig. 510.—Section of the Testicle and its Coverings Showing the Tunica Vaginalis as if Distended.

1, Skin; 2, dartos; 3, external spermatic fascia; 4, cremasteric fascia; 5, infundibuliform fascia; 6, parietal tunica vaginalis; 7, visceral tunica vaginalis.

If a transverse section of the scrotum and testicle is now made and the sac of the tunica vaginalis shown as if distended, the parts will appear as in the accompanying diagram (Fig. 510).

The obliteration of the vaginal process of the peritoneum is believed to occur simultaneously from two directions, namely, from the internal ring and from the upper part of the epididymis, the process of obliteration extending both downward and upward until this tubelike portion of the pouch of peritoneum which accompanies the testicle in its "descent," as it is somewhat erroneously called, from its original position in the abdomen and behind the peritoneum, is converted into a fibrous cord between the two points mentioned. The lower portion of this pouch persists as the tunica vaginalis. The "puckering" of the peritoneum at the internal ring, and the obliteration of the funicular process are shown in figure 507.

In the variety known as **congenital hernia** the entire pouch remains precisely as it was when the testicle finally lodged itself in the scrotum. No obliteration takes place, and there is a simple serous tube extending from the internal ring, where it communicates with the general cavity of the peritoneum, and ending in a blind sac at the bottom of the scrotum, in which is placed the testicle. With the slightest intra-abdominal pressure a knuckle of intestine is forced into this pouch and is found in the tunica vaginalis lying in contact with the testicle. This variety is not frequently met with (Fig. 511).

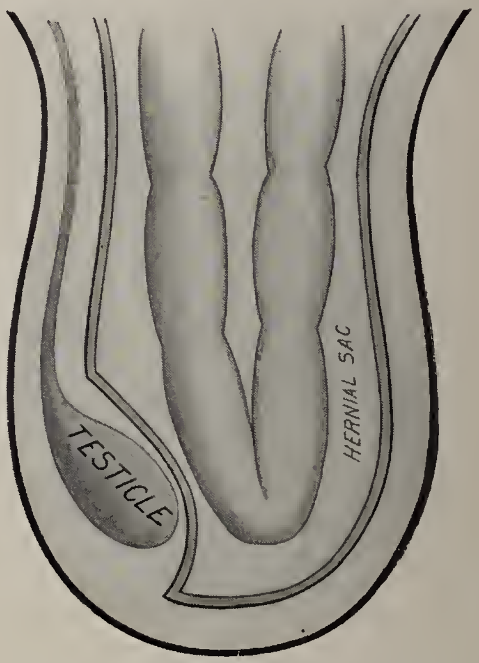

Fig. 511.—Congenital Hernia. Descent of intestine into the unobliterated tunica vaginalis.

Should occlusion occur at the internal ring alone, the cavity of the tunica vaginalis becoming continuous with that portion of the vaginal process which remains unobliterated below the level of the latter, either one of two varieties of hernia may be produced. Should the pressure be exerted on the peritoneal surface behind the point of occlusion (see arrow mark), the variety known as **infantile hernia** will occur (Fig. 512). The peritoneum in the neighborhood of the septum or point of occlusion of the vaginal process gradually yields and forms a sac for the hernia as it descends. Under these circumstances there are three layers of peritoneum in front of the protruded intestine, these including the two layers of peritoneum and the hernial sac itself (Fig. 513). If, however, the pressure takes place on the summit of the septum or point of occlusion of the vaginal process, and this is particularly likely

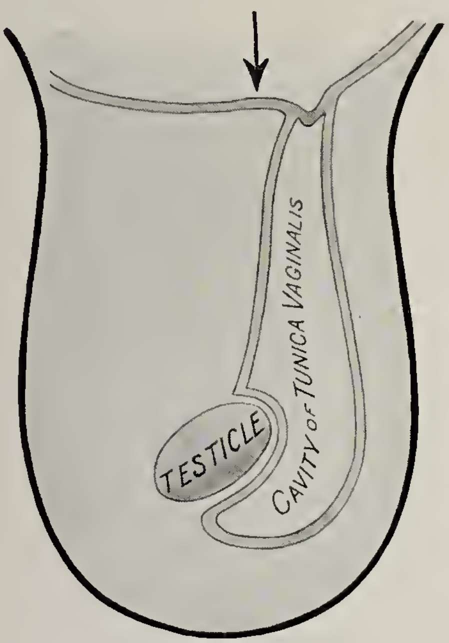

FIG. 512.—INFANTILE HERNIA.
The arrow shows the portion of the peritoneum from which the sac is formed.

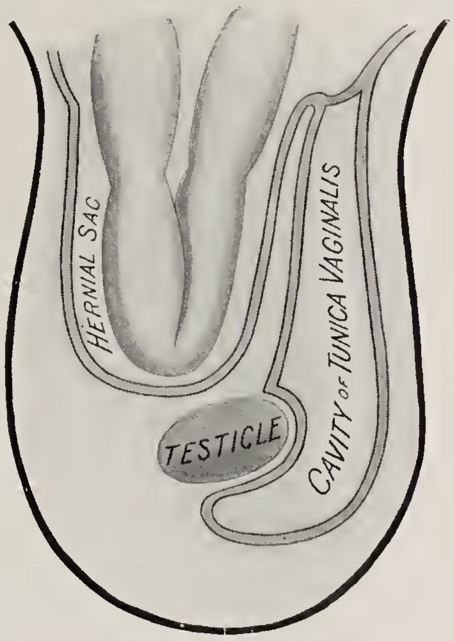

FIG. 513.—INFANTILE HERNIA.
Showing the formation of the sac and the three serous coverings of the hernia, *i. e.*, the two layers of the tunica vaginalis and the hernial sac proper.

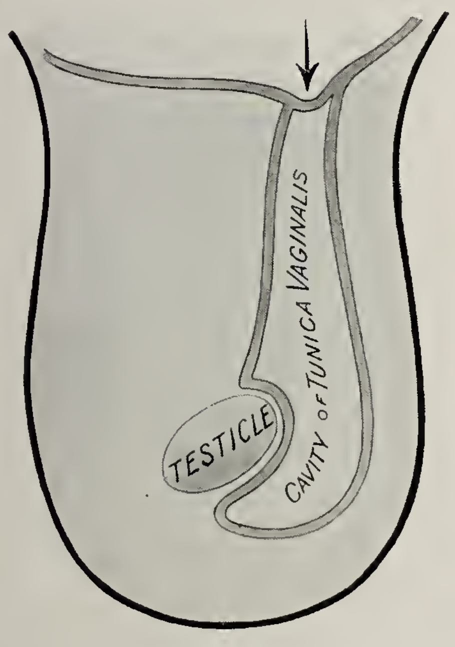

FIG. 514.—ENCYSTED HERNIA.
The arrow shows the portion of the peritoneum from which the hernial sac is formed.

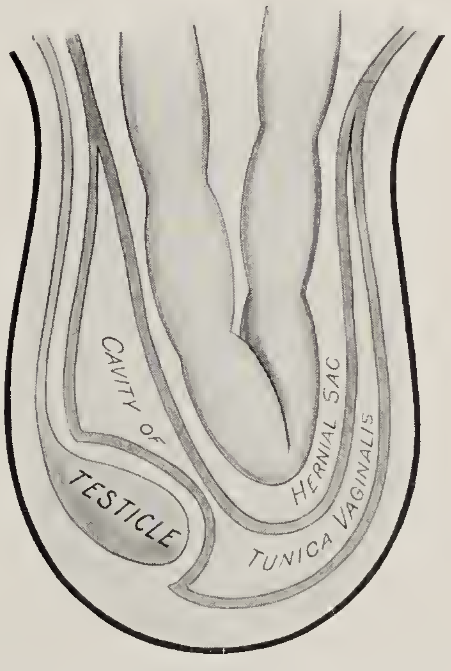

FIG. 515.—ENCYSTED HERNIA.
Showing the formation of the sac, and the two serous coverings of the hernia, *i. e.*, one covering derived from the tunica vaginalis, and the other the hernial sac proper.

to occur if an inviting dimple is left at this point in the process of obliteration (Fig. 514), the septum itself yields, and by a stretching process finally comes itself to form a sac, and what is known as an **encysted hernia** is formed. In the production of encysted hernia a sac is formed within a sac, *i. e.*, the

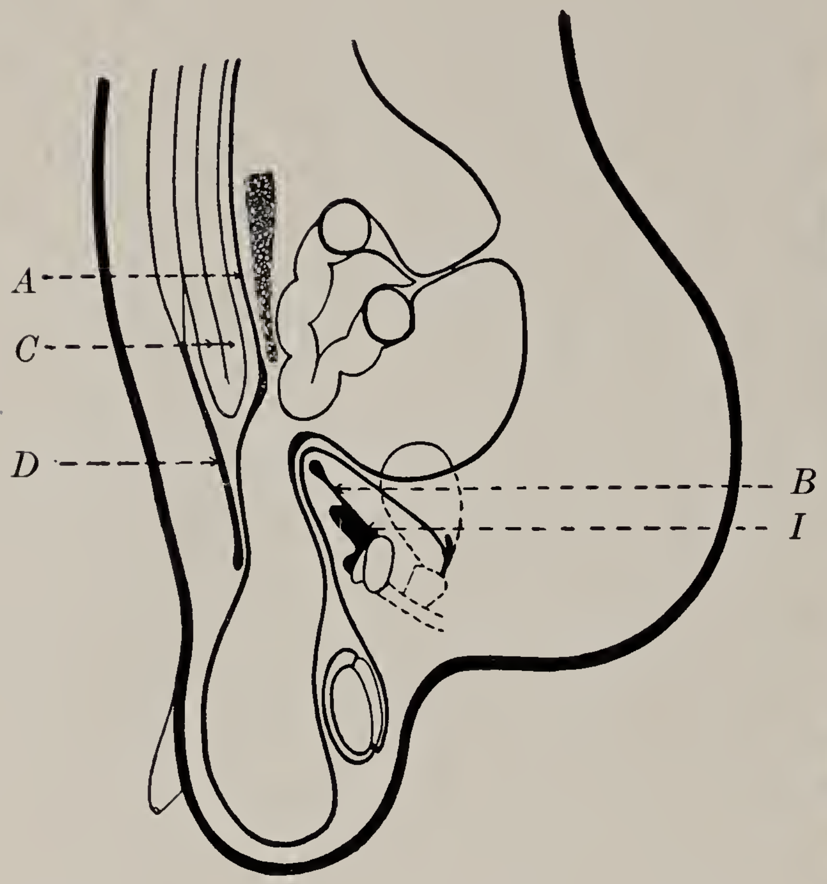

Fig. 516.—Acquired Oblique Inguinal Hernia.
A, Peritoneum; *B*, transversalis fascia; *C*, internal oblique and transversalis muscles; *D*, aponeurosis of the external oblique; *I*, Poupart's ligament.

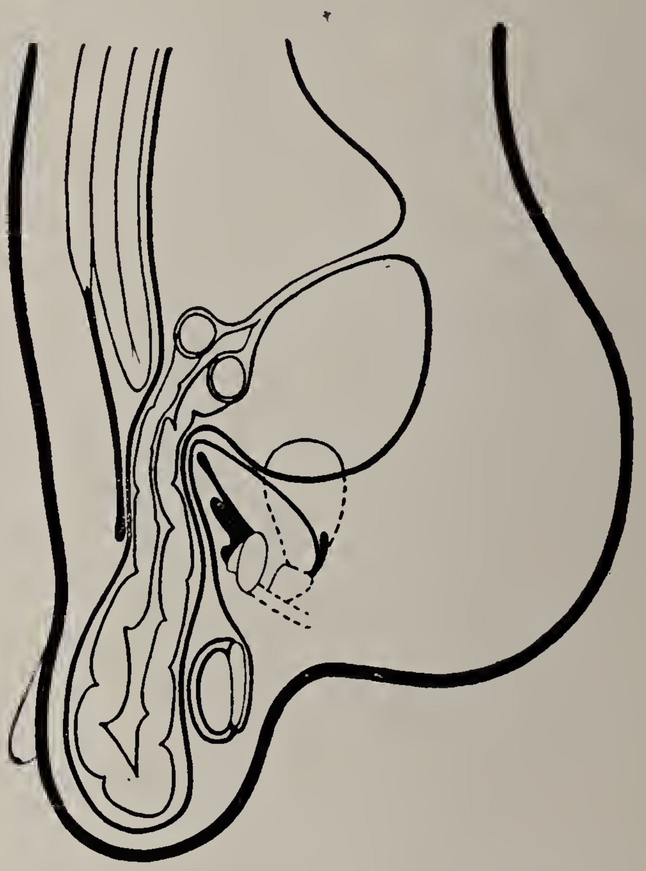

Fig. 517.—Enterocele or Intestinal Hernia.

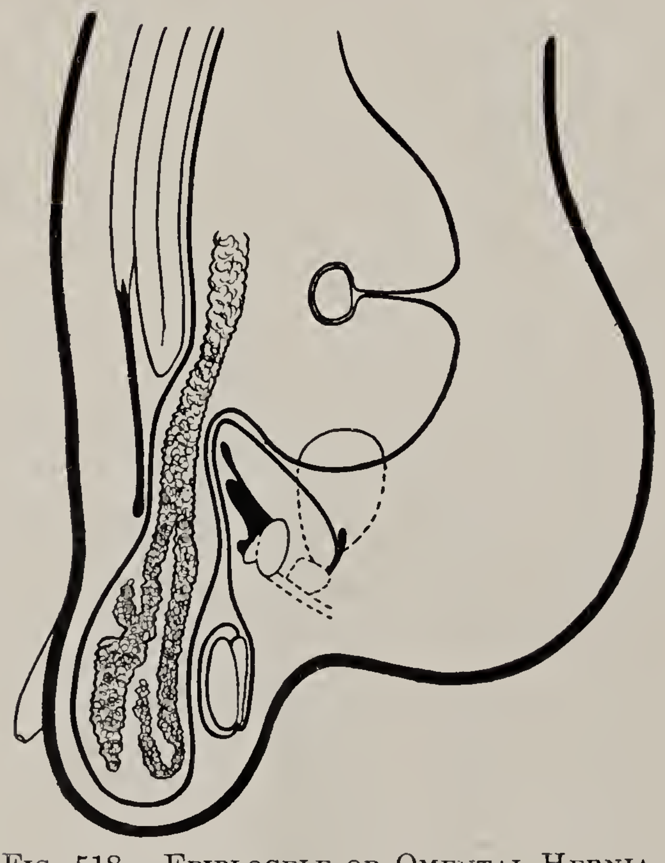

Fig. 518.—Epiplocele or Omental Hernia.

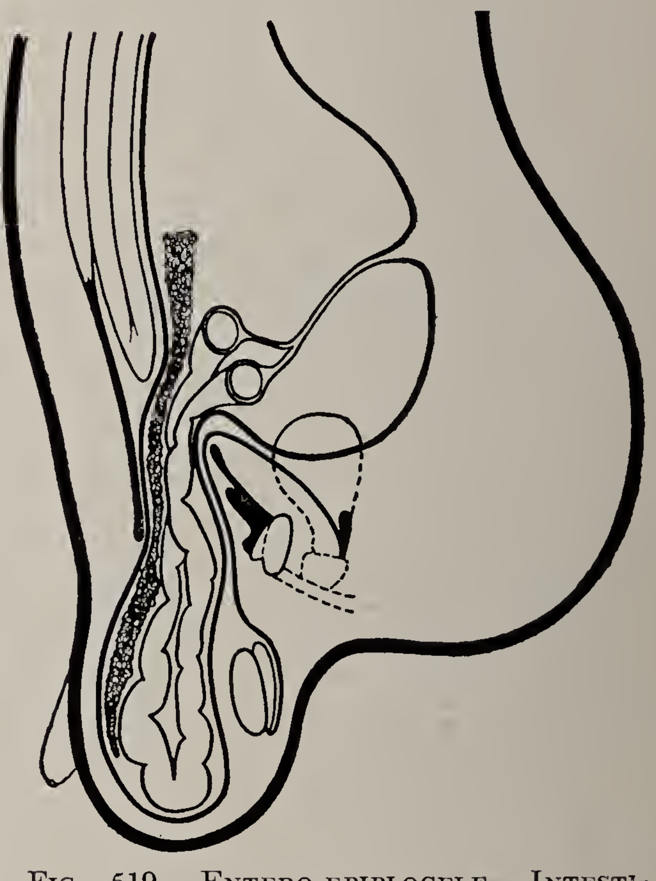

Fig. 519.—Entero-epiplocele. Intestinal and Omental Hernia.

Acquired Inguinal Hernia.

hernial sac is formed **within** the tunica vaginalis, while in infantile hernia the hernial sac is formed **behind** the sac of the tunica vaginalis. As before stated, in infantile hernia there are three layers of peritoneum in front of the bowel, but in encysted hernia there are but two, one layer consisting of the tunica vaginalis and the other of the hernial sac (Figs. 513 and 514).

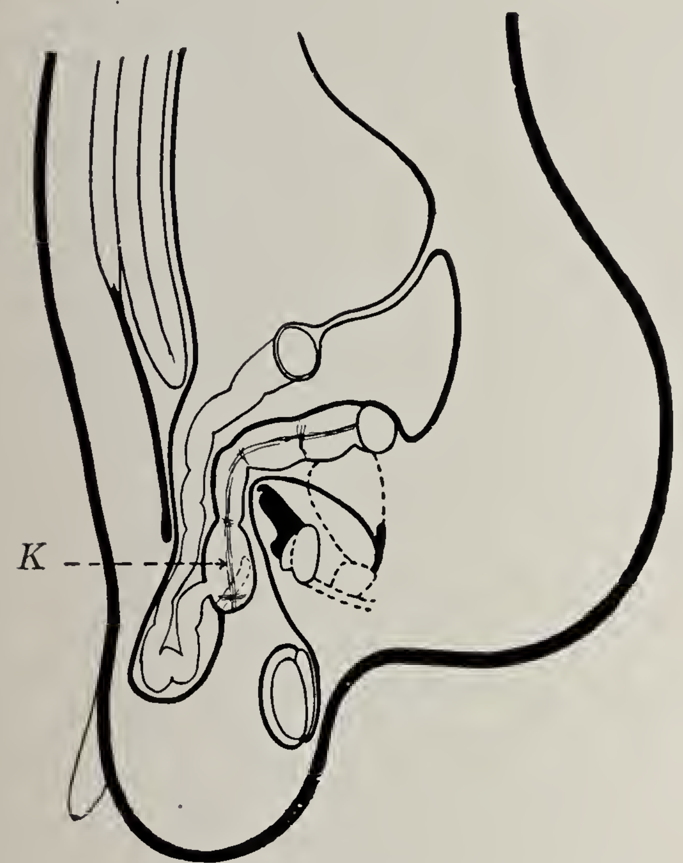

Fig. 520.—Cecal Hernia, Showing the Cecum with its Covering Forming the Posterior Wall of the Sac.

Note that the cecum lies apparently outside of the hernial sac and posterior to it. This is also adherent to the sac. *K*, Cecum.

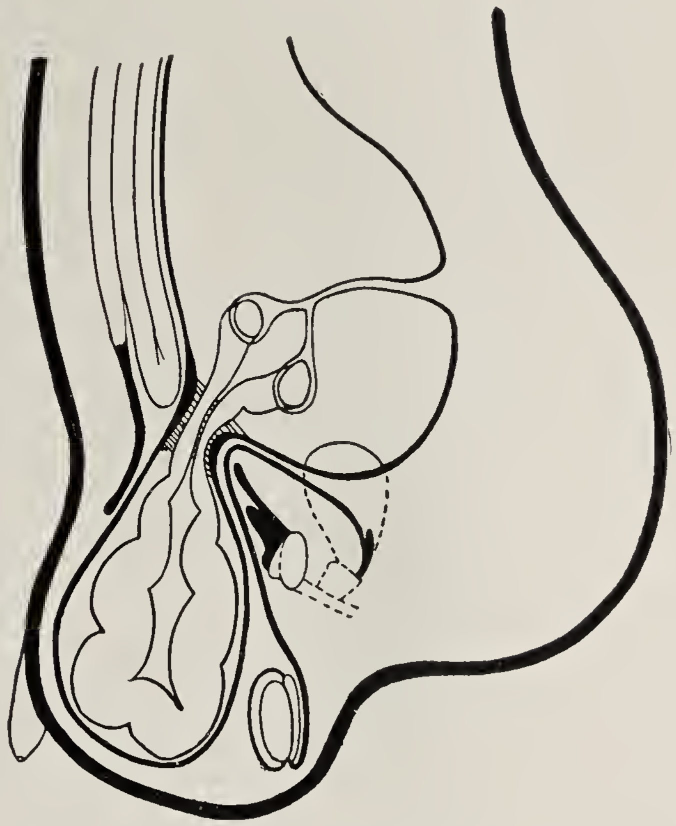

Fig. 521.—Irreducible Hernia from Adhesions at the Internal Ring.

Acquired Inguinal Hernia—(*Continued*).

Still a fourth variety of hernia is found as a result of congenital failure of closure of a portion of the vaginal process. When there is absence of obliteration of the upper part, that portion of the pouch just above the testicle alone being occluded, the vaginal process is divided into two unequal parts. The lower or lesser portion represents the tunica vaginalis proper, while the upper or larger portion forms what is known as the **funicular process** (Fig. 507, G). Here the intestine descends into the pouch of peritoneum as far as the point of occlusion just above the testicle, where it is arrested and prevented from becoming a true congenital hernia by the septum which intervenes between it and the cavity of the tunica vaginalis. This unobliterated funicular process is also the seat of a communicating hydrocele (Fig. 522). The distinctions to be noted between the mechanism of the production of the varieties of hernia just described and

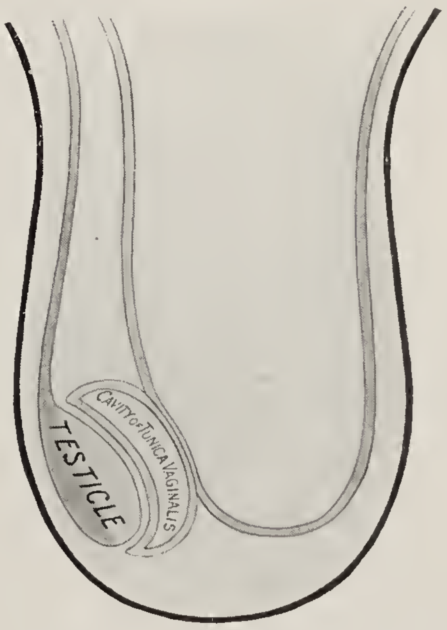

Fig. 522.—The Unobliterated Funicular Process in Which a Communicating Hydrocele Forms.

common scrotal hernia are shown in figure 524. It is to be noted that the hernial sac in this variety is entirely distinct from the tunica vaginalis, which has become obliterated.

Acquired Inguinal Hernia.—In order to make provision for the final lodgment of the testicle in the scrotum in the male and to afford support for the uterus in the female, in the development of the abdominal wall the muscular and tendinous structures, instead of forming a complete enveloping cover, stop short of this in the inguinal region, the final arrangement being effected in such a manner as to leave certain points of entrance and exit and a proper route for the testicle in the male and the round ligament in the female. These points of entrance and exit are known as the internal or deep and the external or superficial abdominal rings and the passage itself as the inguinal canal. At the same time every effort seems to have been made in the process of evolution to correct existing anatomic shortcomings and to compensate for necessarily weakened mechanic conditions.

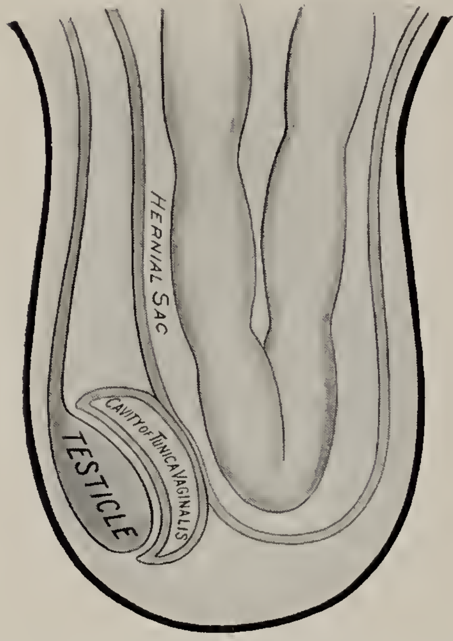

Fig. 523.—Hernia into the Funicular Process of the Peritoneum.

In addition to the peculiarities of development incident to the descent of the testicle, there are others which have more or less to do with the occurrence of inguinal hernia. Briefly, these refer to the presence of certain isolated concave portions of the internal surface of the abdominal wall.

When viewing the inguinal region from the interior of the abdomen, certain more or less distinct fossae or depressions are observed, which are called the **peritoneal fossae.** These are bounded by certain prominent cords or folds of peritoneum caused by the presence of the remains of the urachus, the obliterated hypogastric arteries, and the deep epigastric branch of the external iliac artery. The most important of these fossae are called, from their relation to the deep epigastric vessels, the external and the internal inguinal fossa (Fig. 525). The first named lies to the outer side of the epigastric artery and is the point of exit of external inguinal hernia. The internal inguinal fossa lies to the inner side of the vessel, and is the place of exit of the internal variety of inguinal hernia.

The external is the deepest of the three fossae and contains the pseudo-opening in the transversalis fascia known as the **internal or deep abdominal ring.** The latter lies external to the deep epigastric artery, which, in this part of its course, lies along the inner and lower margin of the ring and beneath the commencement of the spermatic cord. The latter, in the male, and the round ligament in the female pass into the inguinal canal through the internal ring, together with a funnel-shaped process of the transversalis fascia. The internal ring itself lies a fingerbreadth above the level of

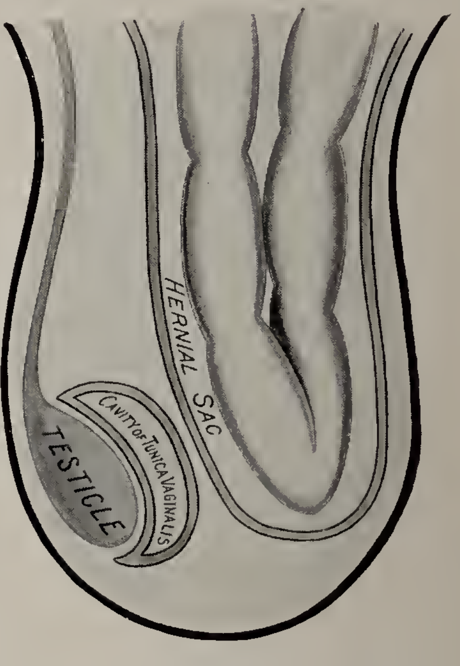

Fig. 524.—Common Scrotal Hernia.

Poupart's ligament and midway between the two points of attachment of the latter.

The inguinal canal is an oblique passage about an inch and a half in length, directed downward and inward from its commencement at the internal abdominal ring to its termination at the external ring.

The **external** or **superficial abdominal ring** is a triangular interval in the aponeurosis of the external oblique muscle. It is bounded on each side by the margins of the opening in the aponeurosis, called the **columns** or **pillars of the ring.** The ring is bounded below by the crest of the os pubis, and above by a series of curved tendinous fibers called the intercolumnar fibers, which serve to strengthen the ring by preventing a further divergence of the pillars from one another.

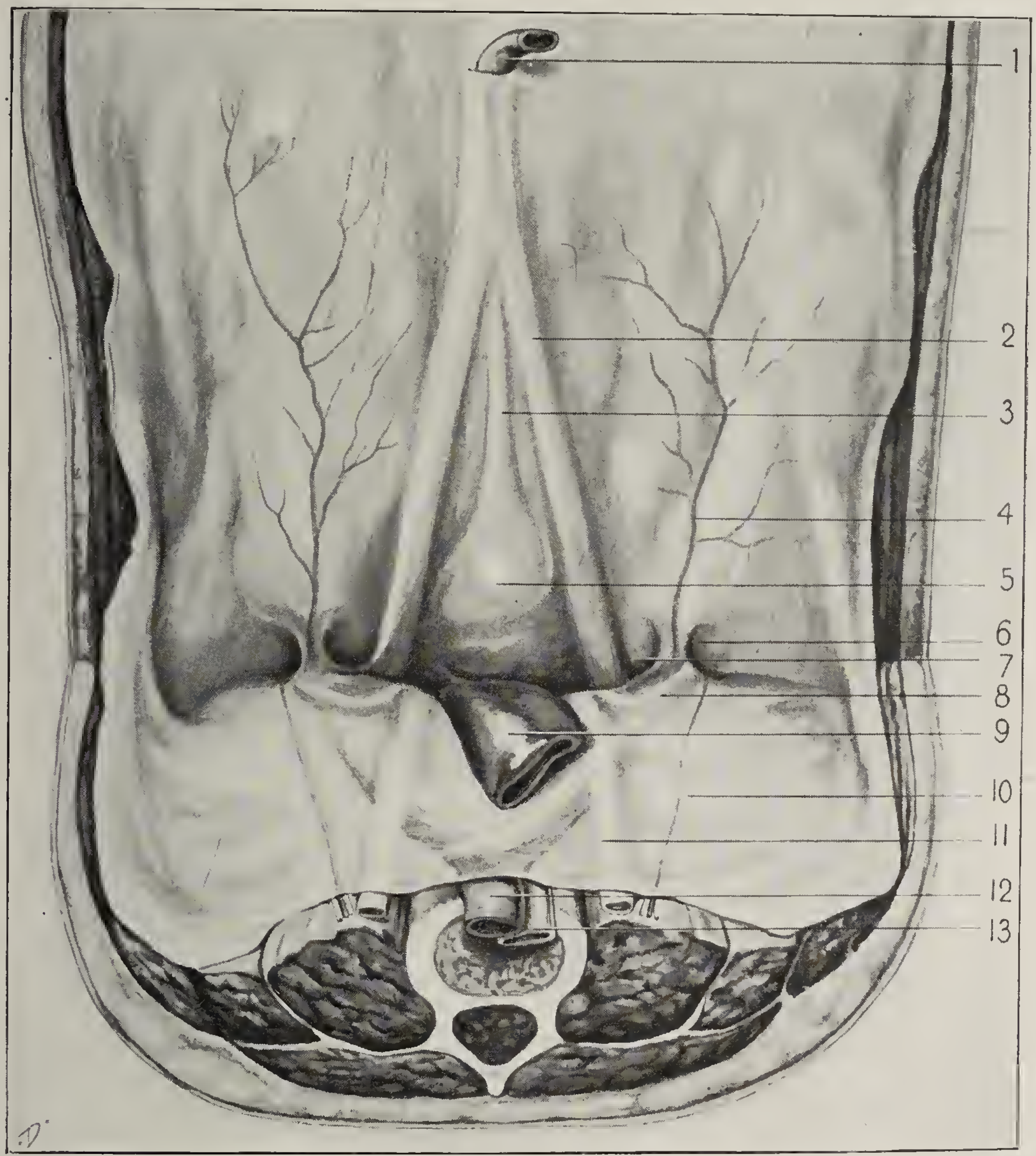

Fig. 525.—Internal Aspect of the Anterior Abdominal Wall of a Newborn Male Child (after Sultan).

1, Hypogastric vein; 2, lateral vesico-umbilic fold; 3, middle vesico-umbilic fold; 4, epigastric fold (deep epigastric artery); 5, urinary bladder; 6, external inguinal fossa; 7, internal inguinal fossa; 8, vas deferens; 9, rectum; 10, spermatic vessels; 11, ureter; 12, common iliac artery; 13, common iliac vein.

The surgical anatomy of the deep epigastric artery bears an important relation to inguinal hernia. The general course of the vessel is represented by a line drawn from a point half-way between the anterior superior spinous process of the ilium and the symphysis pubis to a point on the outer edge of the rectus abdominis muscle midway between the symphysis pubis and the umbilicus. This artery forms a dividing-line between the middle and the external peritoneal fossa, as well as the outer boundary of Hesselbach's triangle (*vide infra*).

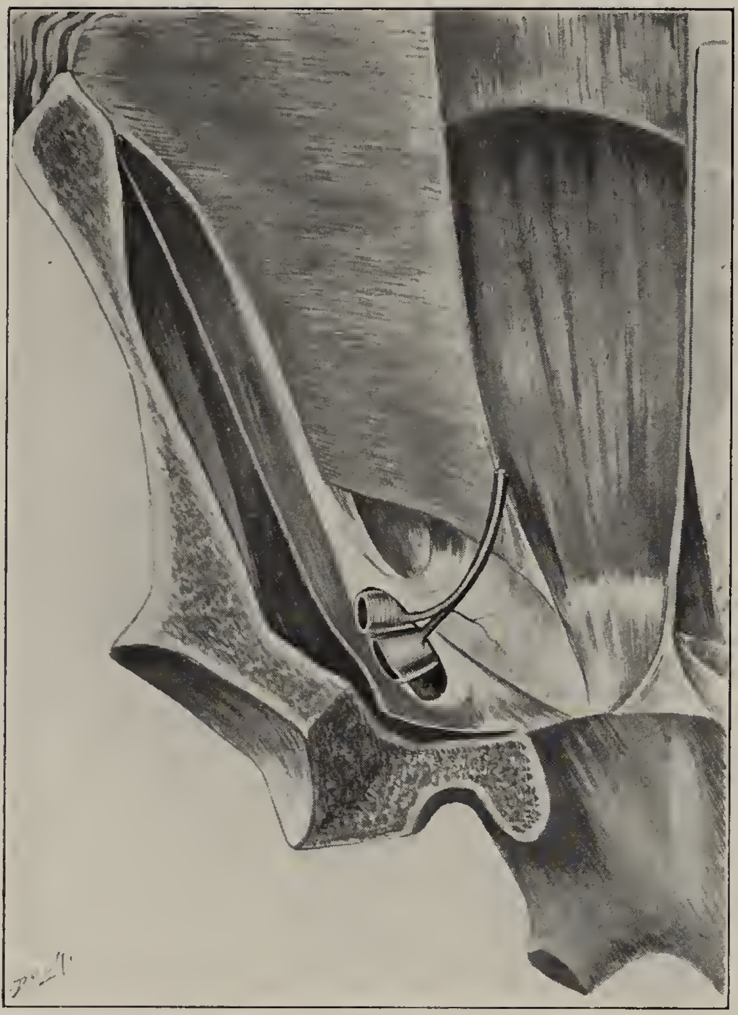

FIG. 526.—HESSELBACH'S TRIANGLE AND THE DEEP EPIGASTRIC VESSELS.

Inguinal hernias are spoken of as **indirect** when they protrude in an indirect manner, that is to say, when they do not appear under the skin directly opposite the point at which they escape from the abdomen. They are sometimes called **oblique** because of the direction downward and inward which they are compelled to take in following the course of the inguinal canal. They are also called **external** because, in former times, it was considered quite necessary to keep constantly in mind the relation which the deep epigastric artery bears to hernia in this region, in this instance the hernia being external to this vessel. A **direct inguinal hernia** is one which passes more or less directly through the abdominal wall to make its appearance beneath the skin. It enters the inguinal canal through Hesselbach's triangle, a space bounded on the outer side by the deep epigastric artery, on the inner side by the outer border of the rectus abdominis muscle and below by Poupart's ligament (Fig. 526). This is also called **internal** because it lies to the inner side of the deep epigastric artery. From the fact that this hernia traverses the linea semilunaris at its lowest part it has also been called **ventro-inguinal.** By the term **incomplete** is meant a hernia that is still contained within the inguinal canal, not yet having appeared at the superficial or external ring. It is sometimes called a **bubonocele** (Fig. 527). With the exception of the congenital form of hernia, in which the contents descend at once into a preformed sac the result of a failure of closure of the

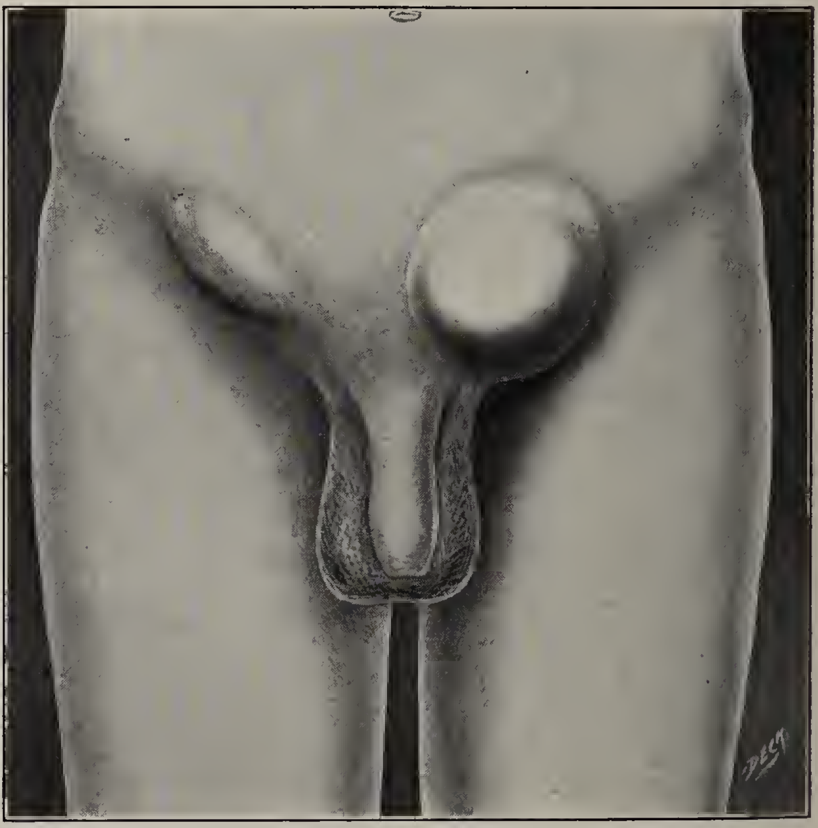

FIG. 527.—RIGHT BUBONOCELE. Left direct inguinal hernia.

vaginal process of the peritoneum developed in the course of the descent of the testicle in intra-uterine life, all inguinal hernias are incomplete before they become complete. A hernia is said to be complete when it has passed out of the canal at the external or superficial ring, and has entered the scrotum in the male and the labium in the female. When the hernia has fully entered and occupies the scrotum, it is called a **scrotal hernia** (Fig. 528); when it rests at any point between the external ring and the bottom of the scrotum, it is called an **inguinoscrotal hernia** (Fig. 529).

An oblique inguinal hernia when occupying the canal alone lies in front of the spermatic cord. In a scrotal hernia the constituents of the cord are often separated and spread out on the hernial sac. In the case of a direct inguinal hernia the cord frequently lies on the outer side of the sac.

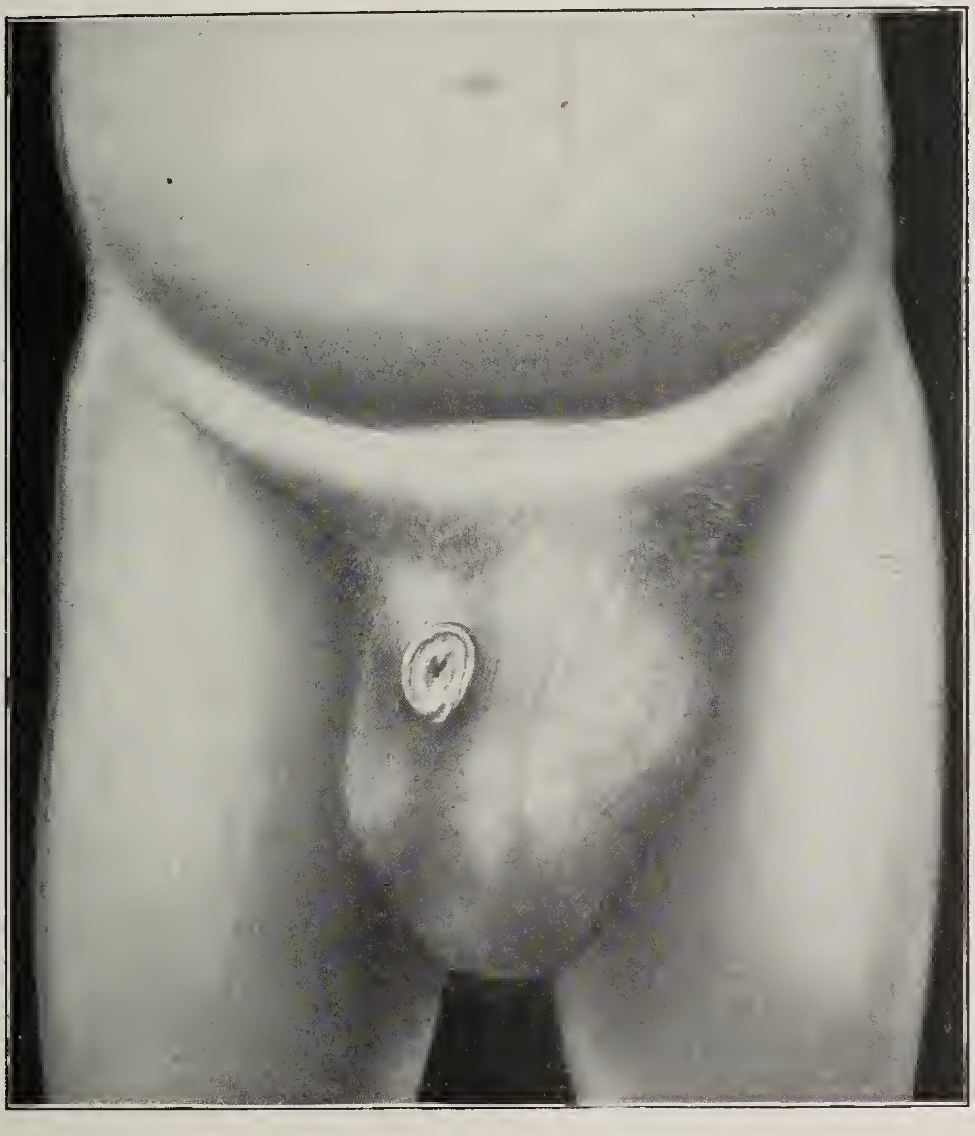

Fig. 528.—Scrotal Hernia.

Inguinal hernia is far more frequent than any other form of hernia, this depending on the anatomic conditions present and incident to the descent of the testicle in the male. The vaginal process of the peritoneum, which precedes the testicle in its descent, is really a sac of itself, into which, under favorable conditions, some of the abdominal viscera may protrude. Should this remain after birth, the conditions are present for the occurrence of a hernia. This, when it occurs, is called a congenital hernia. It will thus be seen that the terms "congenital" and "acquired" as applied to hernia are somewhat arbitrarily employed and that the term congenital hernia does not necessarily imply that a hernia is actually present at birth, but that a hernial sac is congenitally present; the hernia itself may not occur until after many years, or it may never occur.

Inguinal hernia may be present on both sides (**double hernia**); it may be the only variety present, or it may be associated with other forms of hernial protrusion, either on the same side or on the opposite side. An inguinal and a femoral hernia on the same side are not frequently observed, but it is not uncommon to find an inguinal hernia on one side and a femoral hernia on the other side.

Symptoms and Diagnosis of Inguinal Hernia.—A reducible inguinal hernia occurs as a swelling in the inguinal region, first noticed, as a rule, at the site of the internal or deep abdominal ring, reduction of which is effected in an outward, upward, and backward direction.

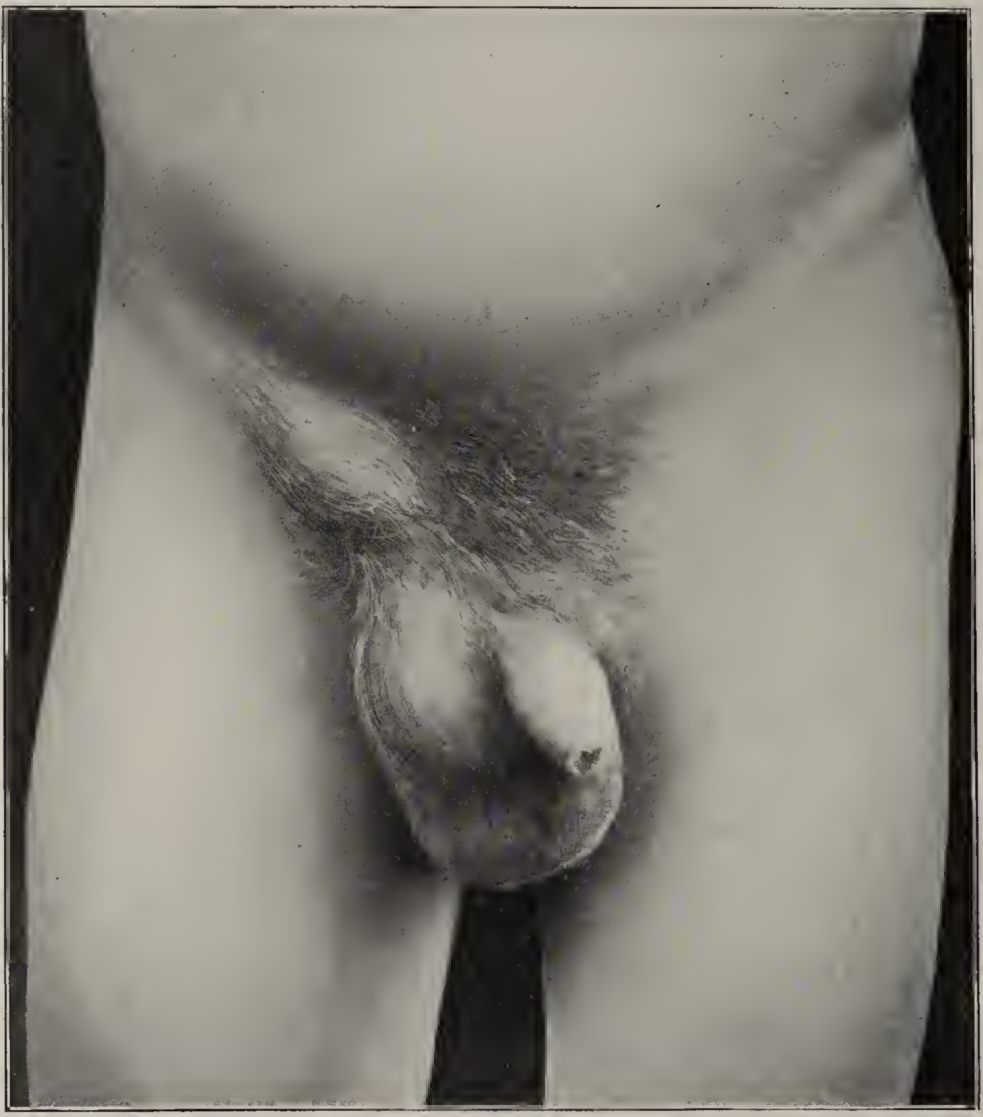

Fig. 529.—Inguinoscrotal Hernia.

Complete reducible inguinal hernia in the male, or **scrotal hernia,** is to be differentiated from varicocele and from congenital hydrocele. There should be no difficulty in making this differentiation if the ordinary signs of hernia are borne in mind. The only sign the three possess in common is the existence of a reducible swelling in the scrotum.

In differentiating a complete inguinal hernia from a femoral hernia, attention is to be given to the following points: (1) a complete inguinal hernia escapes through the external ring to the inner side of the pubic spine, while a femoral hernia lies wholly to the outer side of the latter; (2) in the inguinal variety the canal is occupied where the hernia is protruded, while in femoral hernia the inguinal canal is empty; (3) the protrusion on reduction takes a direction upward, outward and backward in inguinal hernia, while in femoral hernia the reduction is effected in a backward and upward direction. In the female labial hernias are uncommon and constitute about the only swellings in this neighborhood that are reducible.

Complete irreducible inguinal hernia in the male may be mistaken for (1) either a hydrocele of the tunica vaginalis or an encysted hydrocele of the spermatic cord or testis; (2) an acute or chronic orchitis; (3) a neoplasm of the testicle; (4) a hematocele. These all possess in common the one feature of irreducibility, but in typic cases of each there are characteristic features which should enable the surgeon to avoid error.

It should be borne in mind, however, that a hydrocele of a hernial sac may be present and that a hernial protrusion may coexist with a hydrocele of the tunica vaginalis. In the female an irreducible inguinal hernia is rare. The differential diagnosis must take into account (1) glandular swellings; (2) hydrocele of the canal of Nuck; (3) abscesses; (4) lipomas and other tumors; (5) hydrocele of a hernial sac.

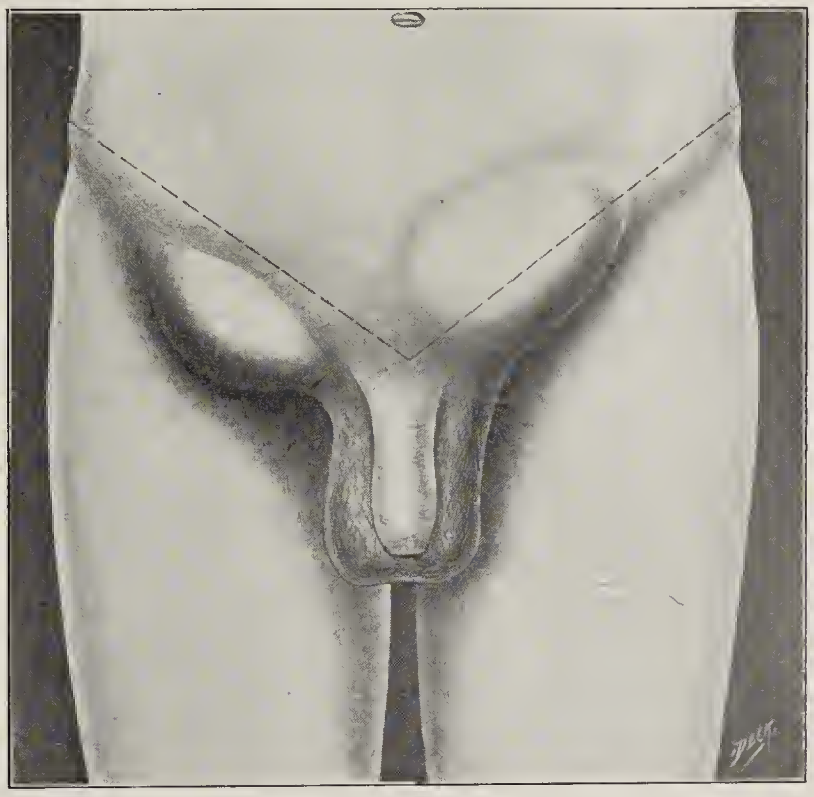

FIG. 530.—DIFFERENTIAL DIAGNOSIS OF INGUINAL AND FEMORAL HERNIA.

The dotted lines show the general direction of Poupart's ligament. The femoral hernia lies wholly below the line, while the incomplete inguinal lies with the greater portion of its bulk above the line.

The differential diagnosis of incomplete reducible inguinal hernia is to be made from the funicular variety of congenital hydrocele, in which the vaginal process of the peritoneum in the male, or the canal of Nuck in the female, is obliterated near the external ring but remains pervious above. The presence of a swelling due to an accumulation of fluid is the only symptom which this condition has in common with hernia. It is of rare occurrence. A small reducible femoral hernia is easily differentiated from an incomplete reducible inguinal hernia by determining the relation of the protrusion to Poupart's ligament (Fig. 530). A large reducible femoral hernia, however, may lie in front of and above Poupart's ligament and simulate an incomplete reducible inguinal hernia. The differentiation is made by noting the following: (1) the swelling lies in front of Poupart's ligament rather than above, while in inguinal hernia it lies wholly above the ligament; (2) the inguinal canal is empty in the femoral variety, while in the inguinal it is occupied by the hernia; (3) reduction is effected in a downward, backward, and finally upward direction in femoral hernia, while in inguinal hernia this is effected in an outward, upward, and backward direction.

The Differential Diagnosis of Incomplete Irreducible Inguinal Hernia.—An irreducible bubonocele is of comparatively rare occurrence in either sex. Enlarged lymphatic glands are the most common source of error. The inflammation which accompanies these swellings, together with their fixed character and superficial location, should serve to differentiate them from hernia. The fact that they may overlie a hernial protrusion should not be overlooked. Abscesses in this region may be the result of lymphatic glandular inflammation and the diagnosis should not be confused because of them. On the other hand, an iliac abscess from Pott's disease may project above Poupart's ligament and may be more easily mistaken for hernia from the fact that it is somewhat reducible and has an expansile impulse on coughing. In the **male** the following must be eliminated: (1) ectopic testicle pure and simple or complicated with hydrocele of its tunica vaginalis; (2) encysted hydrocele of the cord limited to the inguinal canal; (3) hematoma of the cord following an injury; (4) tumors of the cord (lipoma, malignant disease, etc.). In the **female** hydrocele of the canal of Nuck and tumors, particularly lipomas, are to be eliminated.

The Treatment of Inguinal Hernia.—The treatment of reducible inguinal hernia by means of trusses may be considered under three heads: (1) its treatment in childhood; (2) its treatment in adult males; (3) its treatment in adult females.

In childhood there is a natural tendency for the process of the peritoneum in which the herniated viscera descends, to become obliterated. In order to assist this, the tube must be kept empty and its walls in contact. These indications are fulfilled by the **early** application of a properly fitting steel-spring truss covered with hard rubber for cleanliness.

In **measuring for an inguinal truss,** either in an infant or in an adult, the patient should be placed in the dorsal posture, with the lower limbs extended parallel to each other. A tape-measure encircles the patient's pelvis, crossing the base of the sacrum behind, a point half-way between the summit of the great trochanter and the crest of the ilium at the side, and the upper limit of the pubes in front. In children the latter corresponds to a curved line running across the lower part of the abdominal wall, the so-called fold of Venus. The number of inches recorded corresponds to the size of the truss. In measuring for a double truss, one inch is to be added to the actual size, since the almost complete circular spring will not stretch as in the case of single trusses, in which the cross-strap, which completes the circle and holds the truss in place, often stretches considerably with use.

In adjusting the truss in infants it should be borne in mind that there is practically no inguinal canal, and that both the abdominal rings, the superficial lying almost immediately in front of the deep, are above the level of the pubic bone. Therefore the whole of the pad must be above the line of the pubic arch, in order to avoid pressure of the soft parts on the bone. If placed below this line it would be unavailing in retaining the intestine, and, moreover, would produce irritation and excoriation. When it is worn at the proper level and is of the proper size and tension, the intestine is retained and the truss easily kept in position.

The truss should never be removed except for cleansing, and, when not in place, the hernial aperture should be guarded by the nurse's finger or thumb. Its use should not be permanently abandoned for from two to three years even though all traces of the hernia have disappeared.

The diet should be regulated with the view of preventing flatus and distention of the intestines with gas. If phimosis is present, circumcision should be performed.

The Treatment of Reducible Inguinal Hernia in Adult Males by Means of Trusses.—In modern times the fitting of a truss is largely left to skilled mechanicians who follow out specially this line of work. Many of these are far more competent to fit the truss than the surgeon. It is the province of the latter, however, to protect the patient against charlatans and so-called self-adjusting appliances. Attention may be properly paid to the following points:

The pad for an adult should be about four inches long, two inches wide, and one and a quarter inches thick. Its posterior face should continue the line of the inner surface of the spring by means of an offset in the latter (Fig. 531). Its lower border should not project more than a half inch below the level of the spring. The end of the spring opposite the pad in a single truss should be thinner than the rest, in order that the spring may rest easily but steadily on the hip opposite the hernia without causing undue pressure. The springs in all trusses must be so shaped as to present their flat inner surfaces parallel to the inequalities of the surface of the body. Special care should be taken that the truss does not rest on its lower border. In adjusting the under or perineal strap, as it is sometimes called, its initial extremity is secured to that part of the truss which lies directly behind the anterior superior spine of the ilium corresponding to the side on which the hernia occurs, while the strap itself is made to follow the gluteal fold, and is carried above the perineum and up to a stud near the anterior extremity of the pad.

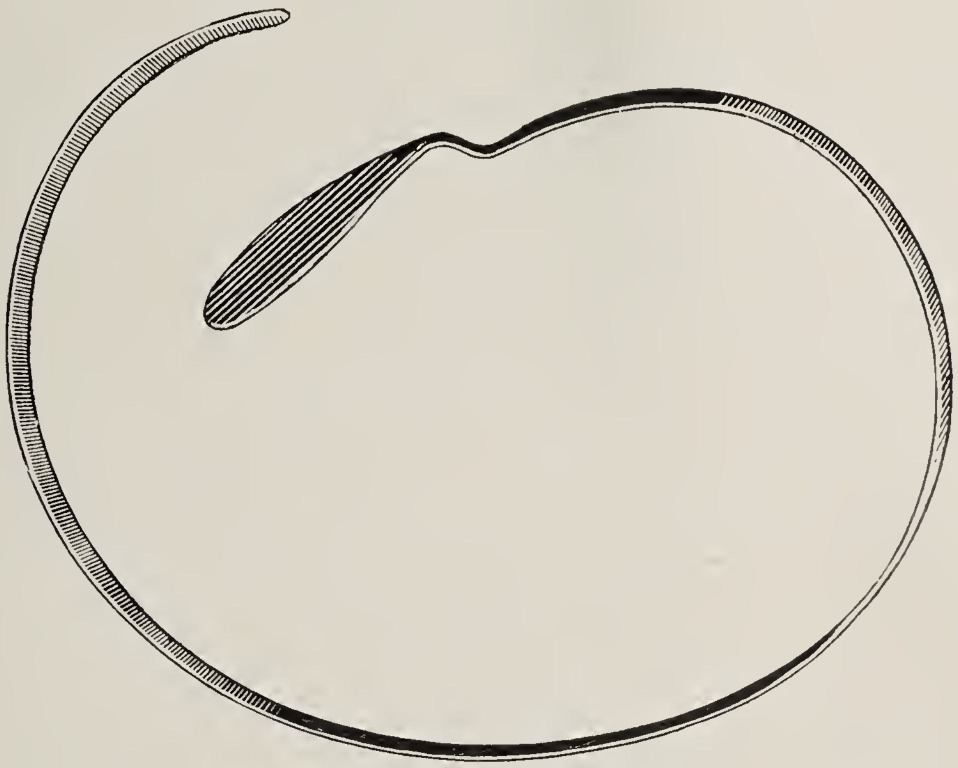

Fig. 531.—Proper Curve of the Spring for a Truss for Inguinal Hernia.

When an inguinal truss is being adjusted, the patient should lie down. With the truss properly held, the pelvis is raised and the truss slipped into position so as to encircle the pelvis. The pad is placed over the region of the deep abdominal ring, rather than over the superficial one. In an ordinary oblique inguinal hernia this will bring the pad near the outer border of the rectus muscle, where it will encroach but slightly, if at all, on the region of the superficial ring. Under no circumstances must the pad lie below the level of the upper limit of the os pubis.

In some cases of **scrotal protrusion** a scrotal truss must be applied (Fig. 534). In this form the pad is prolonged into a strap which takes the place of the ordinary perineal strap. Neither the spring itself, however, nor the metal

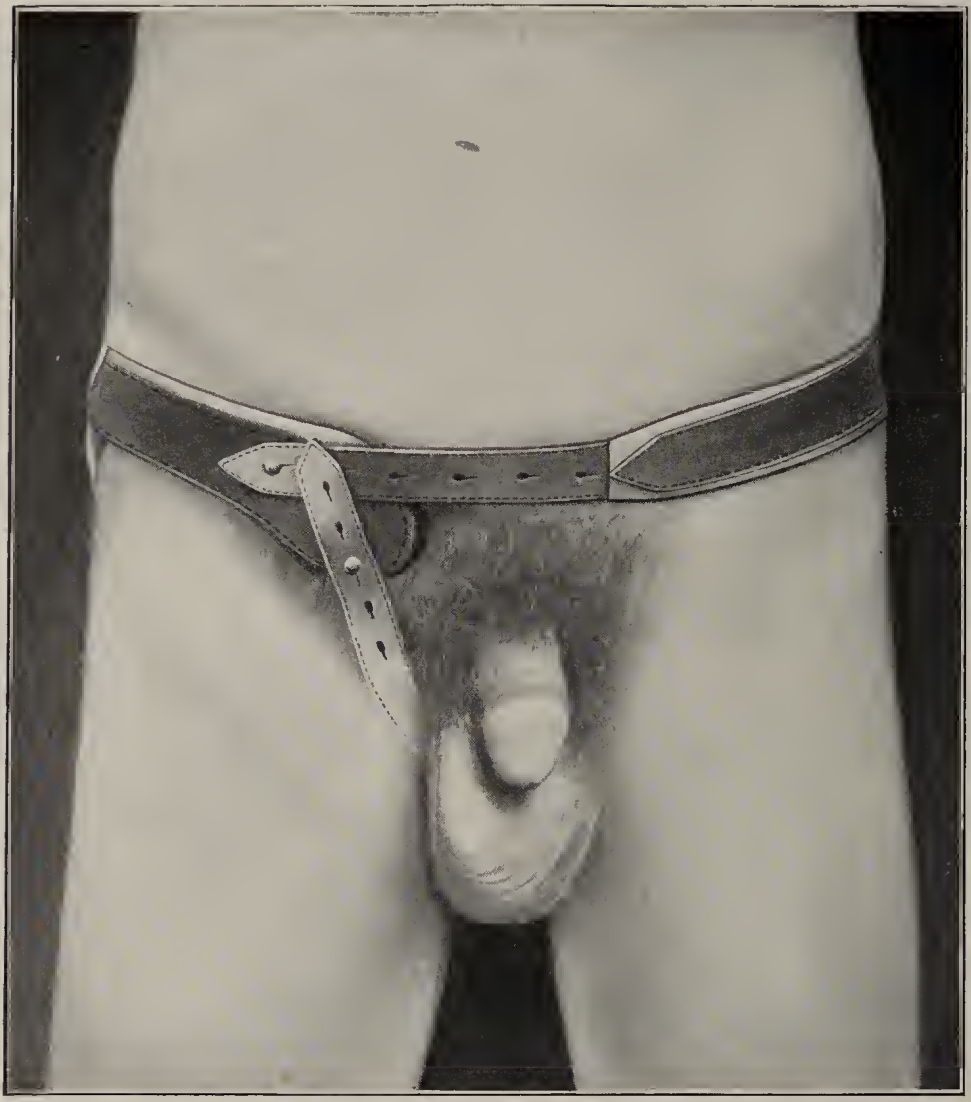

Fig. 532.—Single Inguinal Truss Applied (after Eccles).

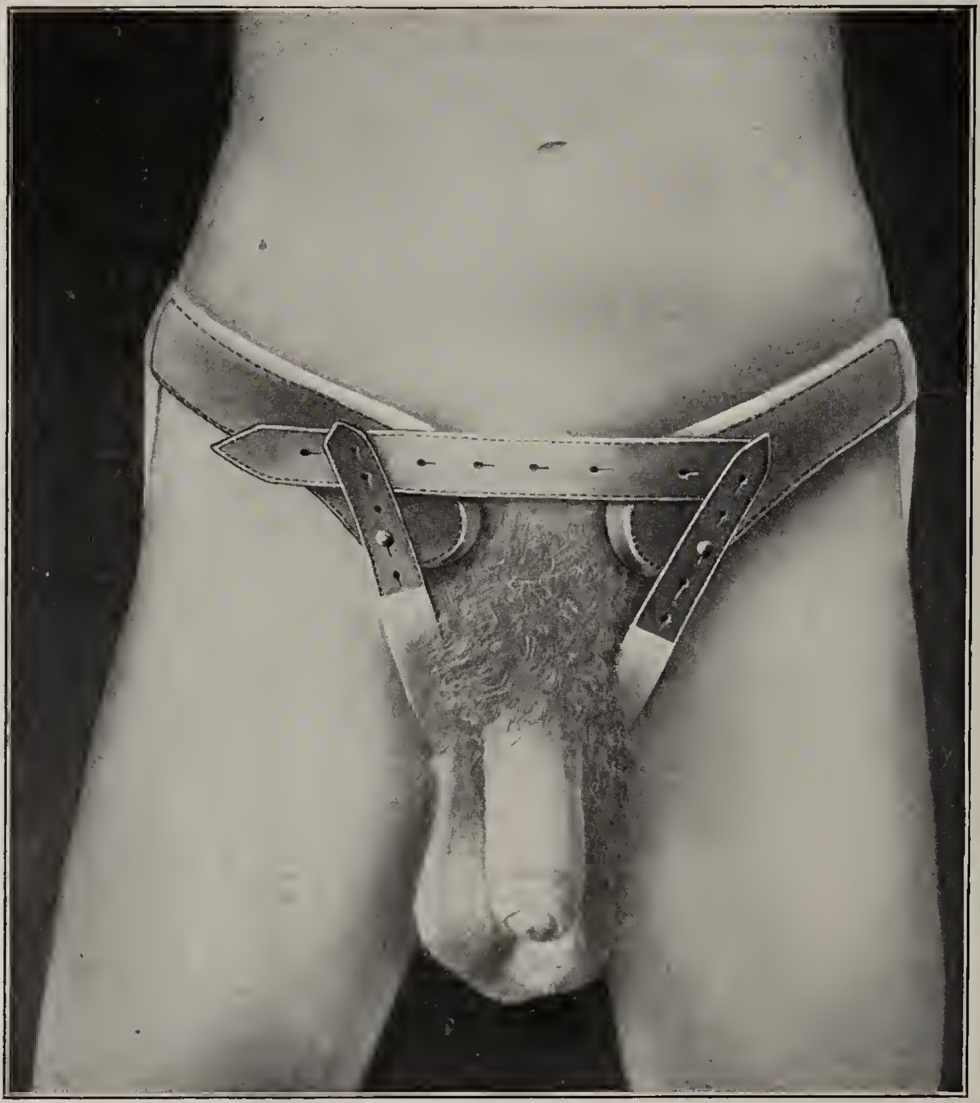

Fig. 533.—Double Inguinal Truss Applied (after Eccles).

base of the pad should be thus prolonged. The spring of a scrotal truss may usually be slightly stronger than that of an ordinary inguinal truss.

In order to obviate the tendency of the upper and inner part of the pad to become displaced downward and outward, which displacement permits the hernia to protrude at the inner side, an addition is made to the soft material of the pad at its upper and internal angle, and to this is attached a strap, the other end of which is fastened by means of a buckle to the cross-strap in front of the anterior superior spinous process of the opposite side (Fig. 532). In a double scrotal truss requiring this addition, the two pads are simply connected together (Fig. 535).

In the adjustment of all inguinal trusses the apparatus should be worn with its anterior and posterior portions well above the level of the lateral portions, which should be well drawn down below the level of the iliac crests. In some old and feeble individuals, owing to atrophy of the gluteal muscle, there is a tendency for the double truss to slip down behind, in which case the truss may be supported by a suspenderlike arrangement.

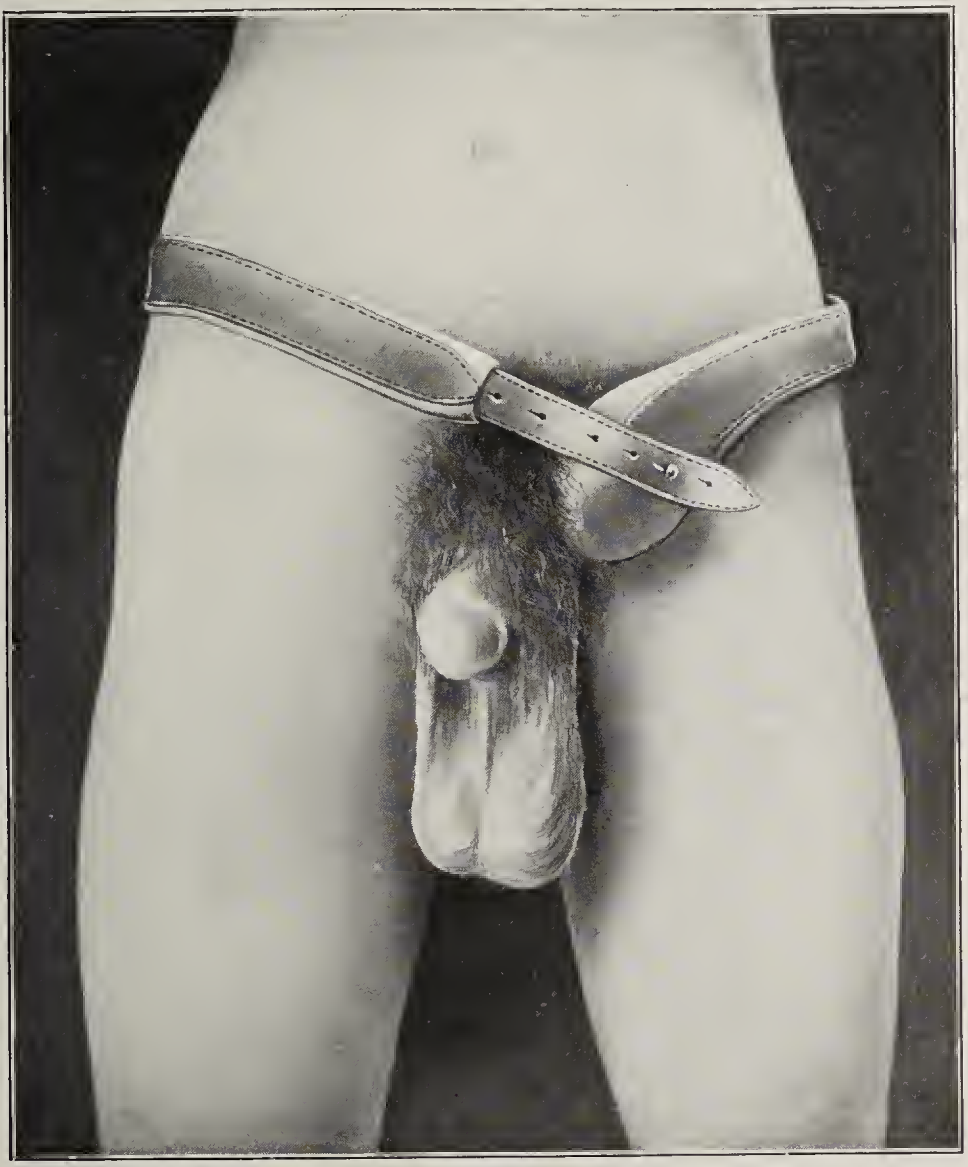

Fig. 534.—Left Scrotal Hernia. Truss Applied.

Reducible inguinal hernia in females is treated as in males. Most of these hernias are incomplete and an ordinary inguinal truss suffices. Labial hernias are treated by the scrotal truss.

The association of a reducible inguinal hernia with a reducible femoral hernia usually occurs when the hernias are on opposite sides of the body. These should be treated by means of a double truss with both an inguinal and a femoral pad. Where the two hernias occur on the same side, a truss with a femoral pad with thigh straps, and an inguinal pad above should be employed.

The treatment of irreducible inguinal hernia by means of trusses is exceedingly unsatisfactory. An inguinal hernia rarely becomes irreducible in childhood, owing to the frequent absence of omentum in the sac. Unless some contraindication exists, cases of this kind, either in childhood or in adult life, particularly if of long standing, should be subjected to the operation for radical cure. If this is not possible, great care should be exercised in regard to both the amount of pressure employed and its correct application. The form of truss most suitable in the treatment of an irreducible scrotal hernia is that known as the "hinged cup." This consists of a flat inguinal pad attached to a circular steel spring, to the lower border of which a cup is attached by means of a hinge; the cup is lined with chamois leather and has a scooped out upper

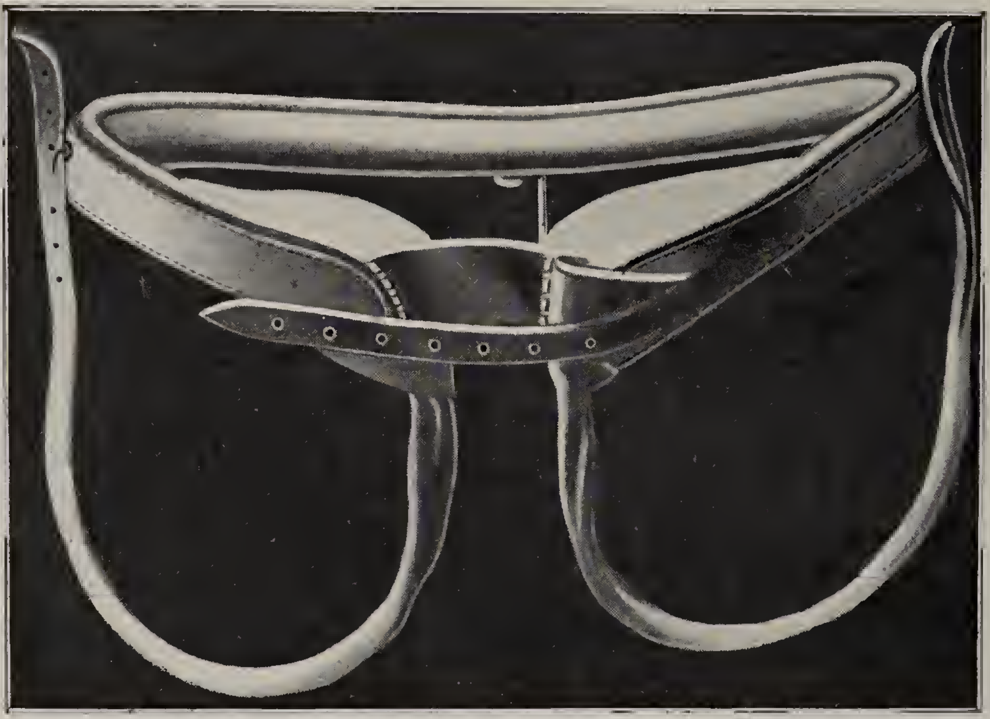

FIG. 535.—DOUBLE SCROTAL TRUSS WITH PADS CONNECTED TOGETHER TO PREVENT DOWNWARD AND OUTWARD DRAGGING.

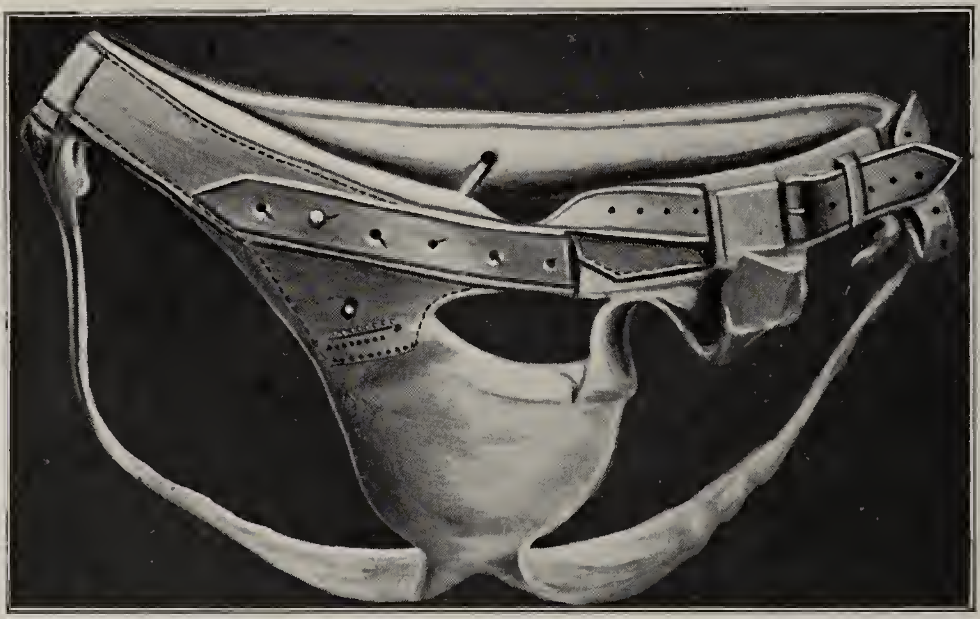

FIG. 536.—RIGHT HINGED CUP TRUSS.

edge for the protrusion of the penis. The perineal straps are attached to the inferior angle of the triangular cup, and a supplementary cross-strap is applied (Fig. 536). The amount of pressure on the sac and its contents is regulated by adjusting the perineal straps. The truss must be worn day and night, and chafing and excoriations prevented by frequent cleansing, followed by bathing the parts with equal parts of alcohol and water and applying fine powdered starch. In cases of irreducible double scrotal hernia, a double hinged cup truss must be worn. In cases of exceedingly large irreducible scrotal hernia, if the hinged cup truss fails to afford comfort, the bag truss must be resorted to, though this latter is but a palliative measure of rather uncertain value.

In a case of **irreducible bubonocele** in which operation is contraindicated, an inguinal truss with a hollow pad is indicated.

Irreducible inguinal hernia in adult females should be submitted to operation whenever possible. Otherwise it should be treated as in males. It is difficult, however, to adjust a hinged cup truss to a labial hernia, and the surgeon must frequently content himself with the application of an inguinal truss, with a hollow pad and thigh straps.

An irreducible femoral hernia and a reducible inguinal hernia may occur together. In such a case the usual form of inguinal pad must be employed in conjunction with a hollow femoral pad.

The Operative Treatment of Inguinal Hernia.—The operative treatment of inguinal hernia consists in (1) operations designed for the radical cure of nonstrangulated inguinal hernia ; (2) herniotomy for the relief of strangulated inguinal hernia.

Indications for Operations Designed for the Radical Cure of Nonstrangulated Inguinal Hernia.—These are distinctly indicated under the following circumstances: (1) in infants and children in whom a properly fitting steel spring truss, worn continuously for at least three years, has not effected a cure; (2) in infants and children whose parents are too poor to supply a truss, or too ignorant to care for its proper adjustment or to prevent excoriations from uncleanliness when a truss is supplied; (3) in male infants, children, and young adults in whom the hernia is complicated by ectopic testicle situated at the site of the internal ring or in the inguinal canal; (4) in young adults and individuals in middle life in whom no contraindications exist, and in whom a properly adjusted truss fails to retain a reducible hernia; (5) in properly selected cases of irreducible hernia; (6) in those desirous of entering the public services; (7) as a precautionary measure, in those about to remove to remote localities where properly fitting trusses cannot be obtained or where, in case of irreducibility or strangulation surgical skill would not be available; (8) in cases of previous or actually present strangulation; (9) in the young or middle-aged whose resources are such as to prevent them from receiving the benefits of a properly adjusted truss, or whose intelligence is not sufficient to appreciate the necessity of a constant and watchful care in the use of the truss when properly fitted and applied.

The best results from the radical operation are obtained in female children, in whom there is no necessity for maintaining the patency of the inguinal canal. In general the results obtained in children are better than in adults. Further, in the case of adults, the percentage of recurrence is greater in those with old hernias, and in those who have worn trusses a long time, with consequent degenerative changes and atrophy from truss pressure. Finally, those with fat, flaccid, or bulging abdominal walls, particularly in the inguinal regions, those past middle life with protuberant abdomens, and those suffering from any visceral disease, are most unsuited for operation.

The Choice of Operation for the Radical Cure of Inguinal Hernia.— This will depend on the character of the case. In infants and young children the simplest form of operation, namely, that of exposure of the sac, isolation of the cord, ligation of the neck of the sac and removal of the latter, and closure of the canal by means of a single row of sutures, with the cord placed in its normal position, will give almost uniformly favorable results. In older children, and in young adults with recent hernias, who have never worn a truss, the operation of suturing the conjoined tendon to Poupart's ligament with one set of sutures, and closing the incision in the aponeurosis of the external oblique with another set of sutures, suffices. In young adults with hernias of longer standing, the preference will be for the operation consisting essentially of the formation of a new canal in front of the internal oblique and transversalis and behind the aponeurosis of the external oblique (Bassini). In middle-aged adults with comparatively recent hernias the same operation may be selected. In the case of those in middle life with old hernias, of those further advanced in years on whom it is advisable to operate at all, and of those of any age in whom there is present a decided general bulging in the inguinal region which has not antedated the hernia but which has developed coincidentally with it, the more elaborate procedures of intraperitoneal displacement of the cord with strengthening of the posterior wall of the canal, or anterior displacement of the cord with overfolding of the aponeurosis of the external oblique, will be required.

The essential steps in all operations for the radical cure of inguinal hernia are as follows: (1) exposure of the sac and its isolation to the level of the internal ring; (2) isolation of the cord; (3) the opening of the sac to be certain that it is empty; (4) removal of the sac, either after ligating it at the neck or after isolating and securing the latter for purposes of subsequent suture; (5) permanent approximation of the conjoined tendon of the internal oblique and transversalis to Poupart's ligament, either with the cord in its normal position, or after its displacement to avoid its presence in the inguinal canal as a predisposing cause in producing the hernia anew; (6) closure of the skin wound.

The most important factor in the technic is the maintenance of aseptic conditions. Good results may sometimes be obtained in the most unfavorable cases, with strict asepsis; on the other hand, the best devised and executed operation will be almost certain to fail of its object in the presence of septic conditions.

The process of "double preparation," *i. e.*, two separate mechanic cleansings of the parts at intervals of twenty-four hours, with the application of antiseptic compresses in the interim, besides the final immediate preoperative preparation, is advisable.

The curved incision (Fig. 537), commencing at the pubic spine, extending first outward and then upward in the line of Poupart's ligament and terminating at the level of the internal ring, is to be preferred. The horizontal portion of the incision crosses the spermatic cord at its most superficial location. This incision permits the turning back of a skin flap, which gives ample room for the subsequent steps of the operation. The parts should be separated by clean cuts of a sharp scalpel, and as little blunt dissection as possible should be done. In the case of the incision in the aponeurosis of the external oblique it is better to prolong the incision above the internal ring than to attempt to overcome difficulties of access by excessive traction upon its edges. While distinctly varicose veins of the cord may be excised in order to reduce the size of the latter, if the removal of the veins is carried too far, excessive swelling of the testicle, or even its loss, may follow.

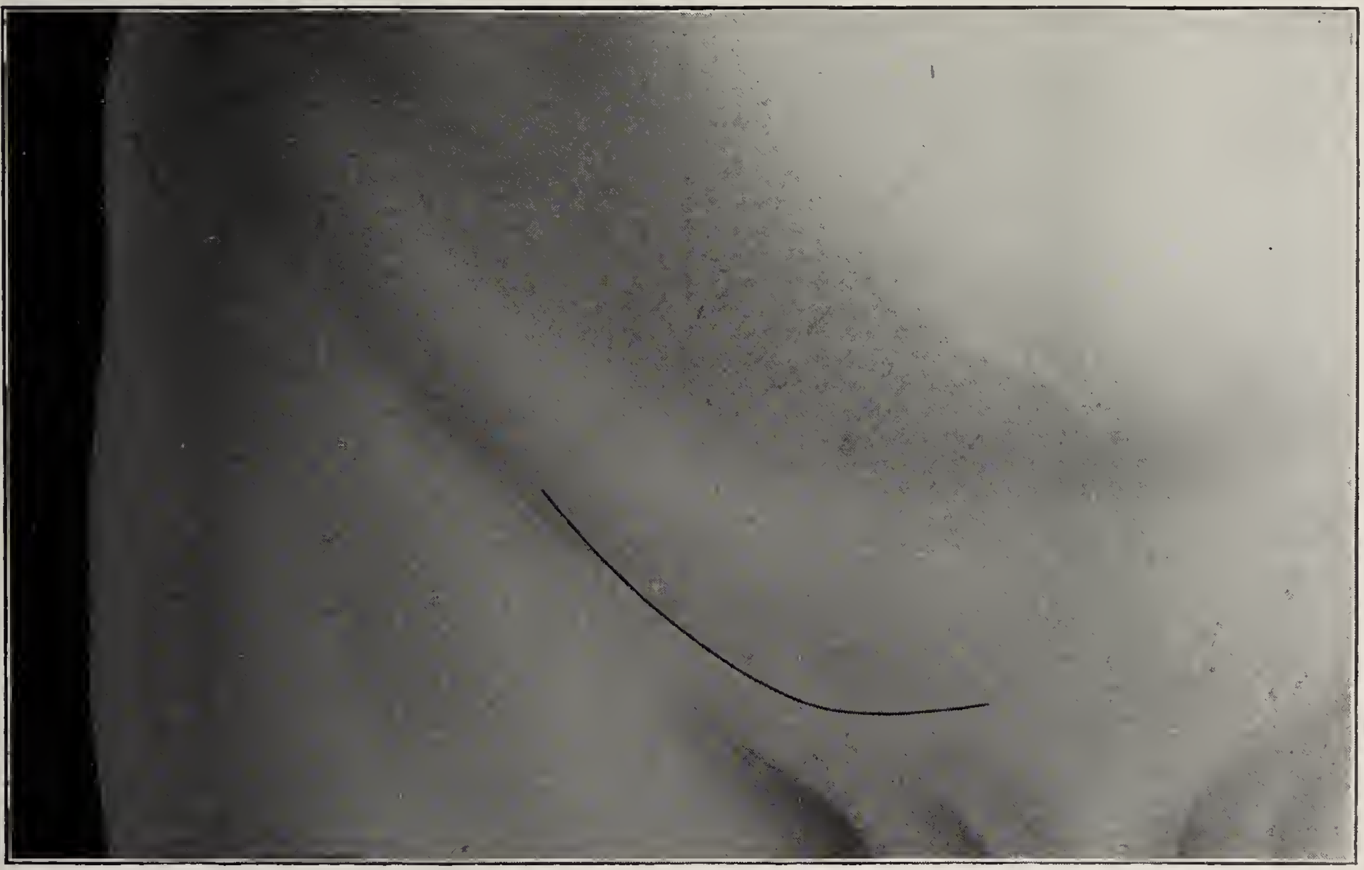

Fig. 537.—The Curved Incision for Operations for Inguinal Hernia.

Simple Ligation and Excision of the Sac and Closure of the Canal in Infants and Young Children.—In this procedure the object in view is to bring about the normal conditions as quickly as possible, and with the least manipulation. The very simplest technic suffices. The sac is cut away in front of a ligature of catgut, the previously isolated cord replaced, and the canal and incision in the aponeurosis of the external oblique closed with two or three through-and-through chromicized catgut sutures placed in a single row (Fig. 538). The external skin wound is closed with a few interrupted silk sutures or the chain stitch, and, in the case of infants, the parts sealed with collodion

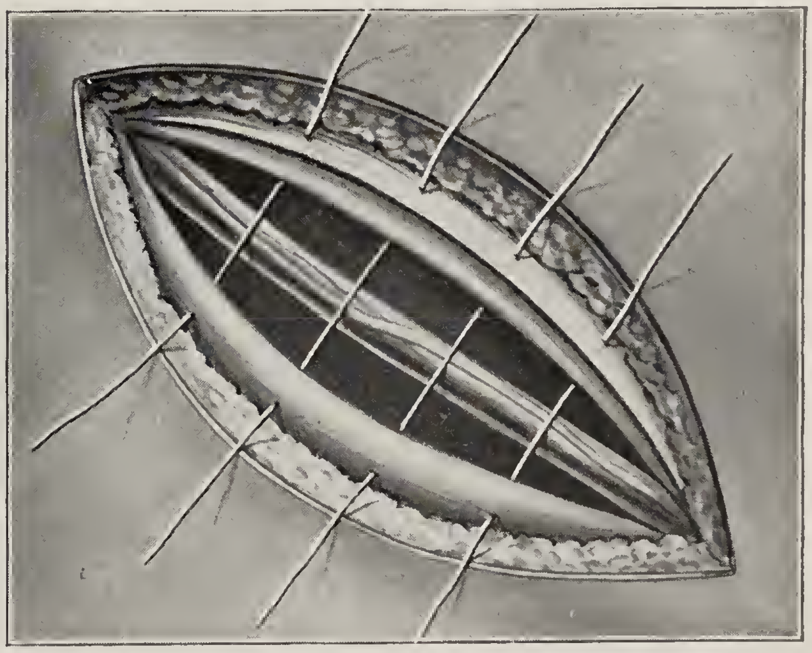

Fig. 538.—Simple Technic for Inguinal Hernia in Children.

and dressed with small compresses of sterile gauze, the thigh being flexed on the abdomen and held there by adhesive plaster and bandages.

Excision of the Sac and Typic Restoration of the Spermatic Canal.—This operation is specially adapted for older children and young adults with recent and untreated hernias. The aponeurosis of the external oblique is separated in the direction of its fibers in such a manner as to leave at least half an inch margin between the outer edge of the incision in this structure and Poupart's ligament. The sac and cord are separated; the latter is cleared to the level of the transversalis fascia, emptied, opened, and the operator's finger passed into the neck of the sac and well beyond the level of the ring to guard against a return of its contents. An assistant now encircles the neck with a catgut ligature, drawing it snugly upon the introduced finger as the latter is withdrawn. The ligature slips over the end of the finger and injury of intestine by the ligature is rendered impossible. The sac is then cut away. The cord is now replaced and the internal oblique and transversalis are sutured to Poupart's ligament with mattress sutures (Fig. 539). Care should be taken not to constrict too tightly the structures within the grasp of this row of sutures, lest the sphincterlike action of the arciform fibers, which it is very desirable to retain in this operation, be interfered with. The incision in the aponeurosis of the external oblique is now closed by overlapping and suturing and the skin wound is closed.

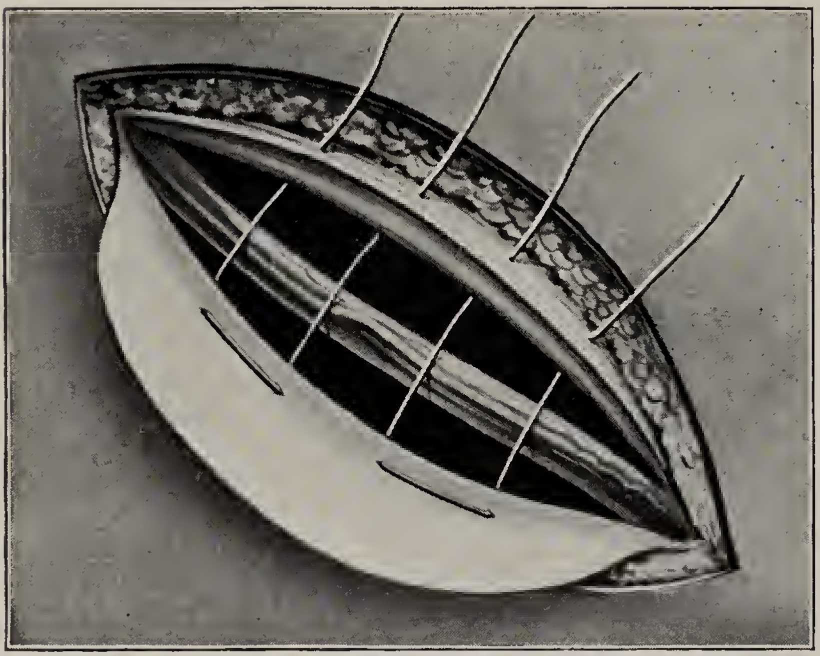

Fig. 539.—Restoration of the Spermatic Canal.

Two mattress sutures are applied. The portion of the aponeurosis of the external oblique reserved for overlapping in the final closure of the canal is shown.

Bassini's operation differs from the foregoing in that the cord is not replaced in its normal position but is placed in front of the line of sutures uniting the internal oblique and transversalis to Poupart's ligament, the aponeurosis of the external oblique being united in front of it. A new spermatic canal is thus formed. Halsted places the cord in the subcutaneous tissue in front of the aponeurosis and toward Poupart's ligament, and Postemski places it in front of the aponeurosis toward the median line. The operation of Bassini, and its modifications, is indicated in hernias that have been in existence for many years, as well as in those that have developed in later life, in which the sphincterlike action of the arciform fibers has been destroyed by prolonged stretching or truss pressure, and in which the success of the operation must depend more on closure of the canal through suturing and the subsequent development of adventitious tissue to maintain the closure than through typic restoration of the parts.

Posterior or Intraperitoneal Displacement of the Cord, with Strengthening of the Relaxed Posterior Wall of the Canal.—There is a class of cases in which there exists a decided bulging in the inguinal region, extending over an area larger than that occupied by the hernia itself. If this is shown by the history of the case to have been absent prior to the development of the hernia, it is probably due to a relaxed condition of the posterior wall of the canal, in which case measures may be taken to lessen this by narrowing the posterior wall. This is done by splitting the latter from the level of the internal ring to as low a point as possible below the level of the pubis, and then closing the gap by suturing. The deep epigastric artery and its accompanying veins must be ligated preliminarily. The cord, previously well freed, is placed in the gap thus formed, entering the latter at the site of the internal ring and emerging at the lower angle of the gap behind the pubic bone, thence continuing over the upper and finally the anterior surface of this bone to its destination. For this distance the cord lies within the peritoneal cavity (Fig. 543). The internal abdominal ring is obliterated and the presence of the cord in the spermatic canal as a factor in causing relapse of the hernia is eliminated. In closing the gap over the cord the loose structures of the relaxed posterior wall of the canal are gathered up and through-and-through mattress sutures applied in such a

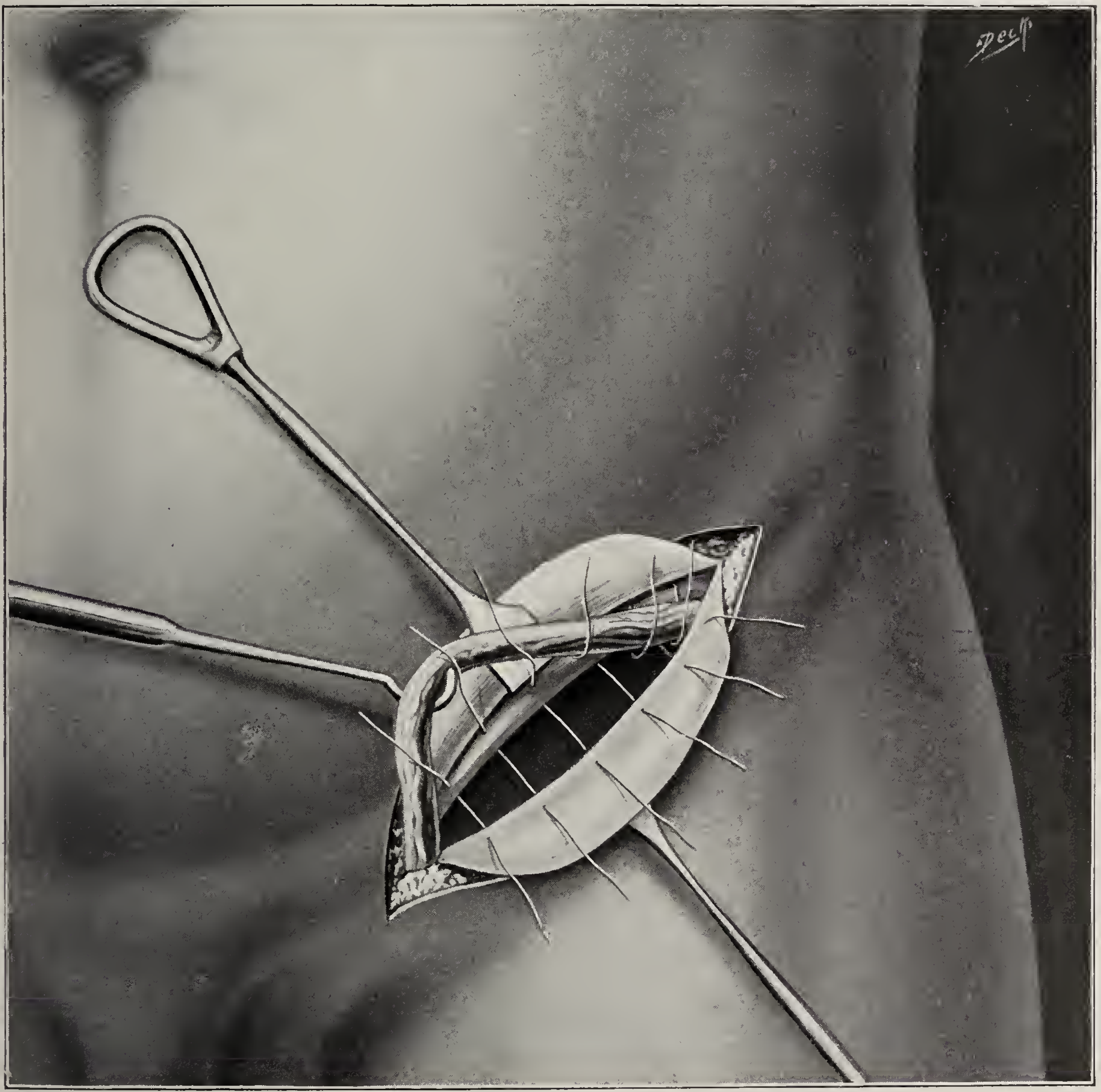

Fig. 540.—Bassini's Operation for Inguinal Hernia.
The sutures designed to approximate Poupart's ligament to the conjoined tendon are in position.

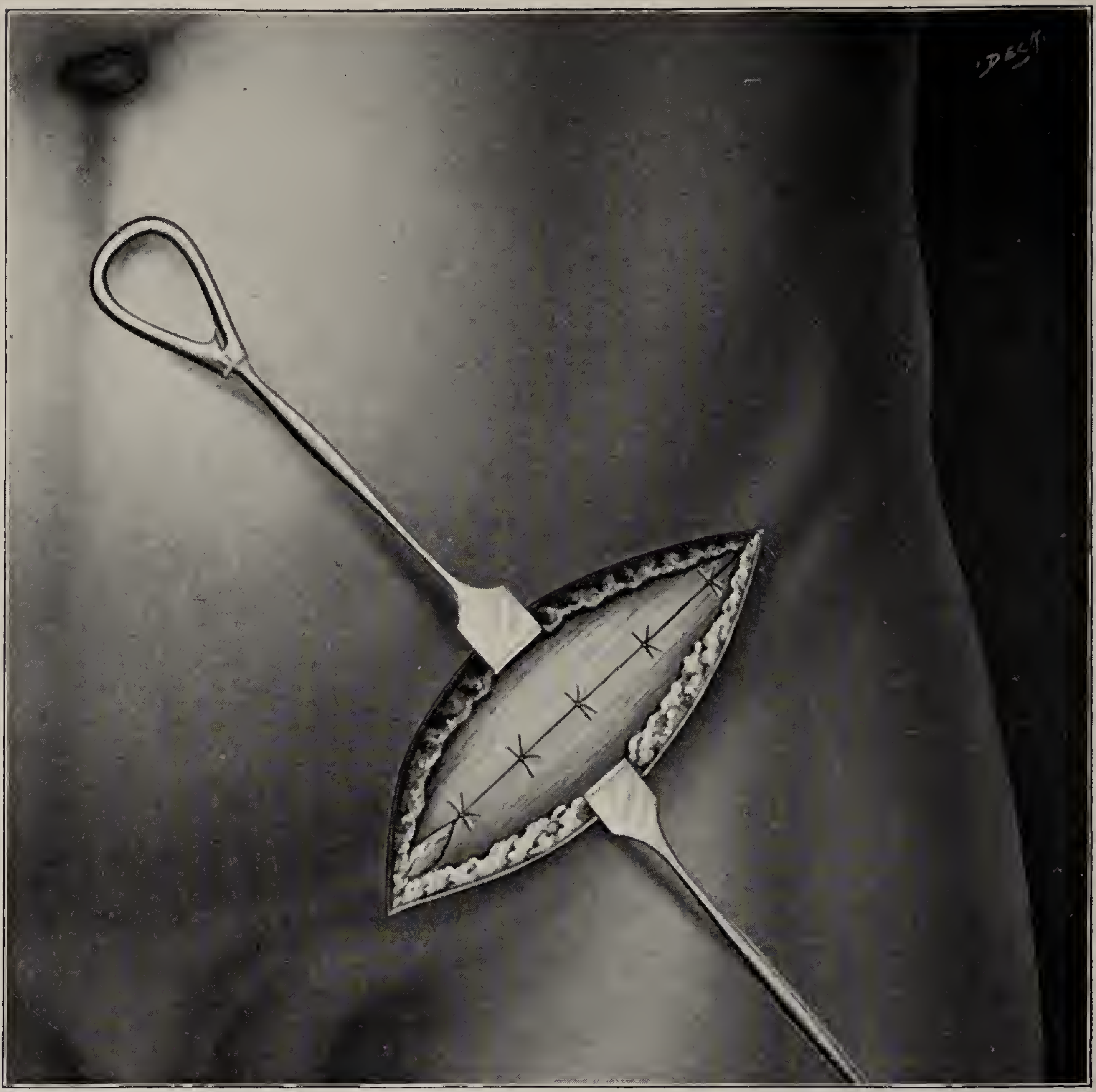

FIG. 541.—BASSINI'S OPERATION FOR INGUINAL HERNIA.
Closure of canal. The cord has been placed in front of the conjoined tendon and the opening in the aponeurosis of the external oblique closed by suturing its edges.

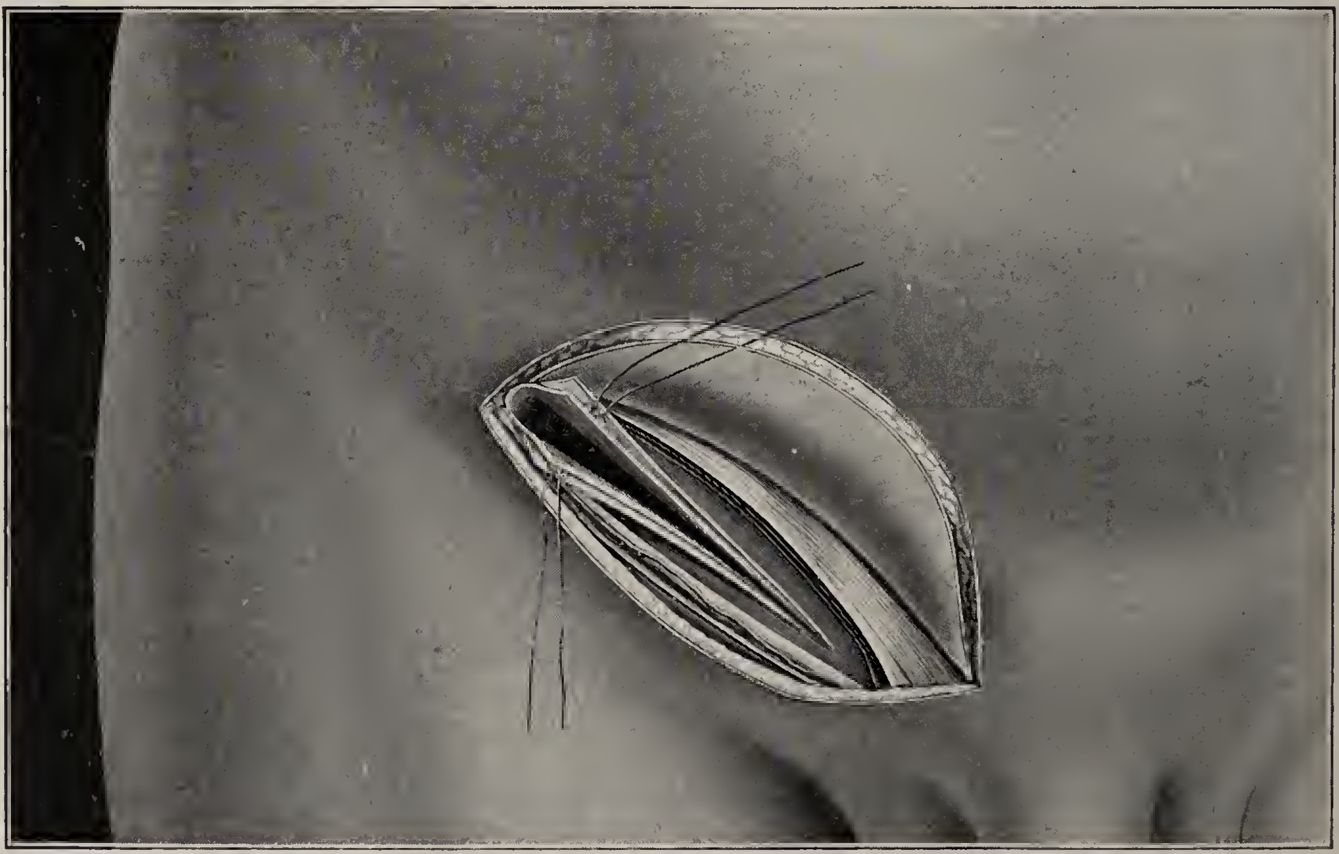

FIG. 542.—INTRAPERITONEAL DISPLACEMENT OF THE CORD.
The deep epigastric vessels ligated and posterior wall of the spermatic canal divided.

manner as to "take up the slack," as it were, so that a projecting seam is left when the suturing is completed (Fig. 544). The inguinal canal is now closed as in the operation for typic restoration of the canal.

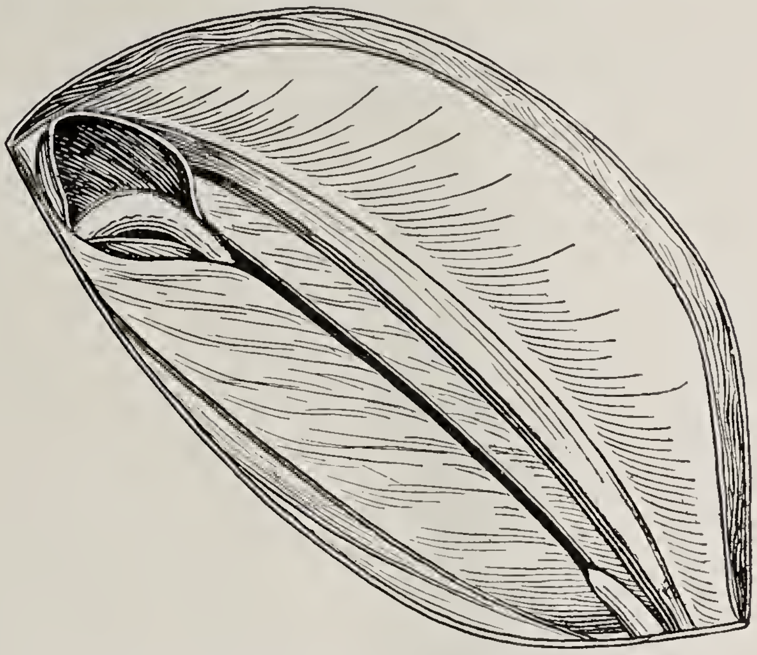

FIG. 543.—SHOWING THE POSITION OF THE CORD AFTER INTRAPERITONEAL TRANSPLANTATION.

Anterior Displacement of the Cord, with Imbrication of the Aponeurosis of the External Oblique.—In this operation the cord and sac are separated and the latter isolated and ligated in the usual manner. The aponeurosis of the external oblique is separated from the conjoined tendon in the direction of the median line for half an inch or more, and in the outward direction for the same distance Poupart's ligament being included. The latter is sutured to the conjoined tendon by three or more mattress sutures (Fig. 545), the cord being held well anteriorly and out of the canal. These sutures, which should be either kangaroo tendon, chromicized catgut, or silk, but never metal, are placed as low down on Poupart's ligament as possible, so as to leave half an inch or more of aponeurosis free. The knotted ends of the mattress sutures should lie on Poupart's ligament. This free edge is now passed *in front* of the cord, which is laid in place, and *behind* the aponeurosis of the external oblique in the direction of the median line, where it is sutured in place by two or more mat-

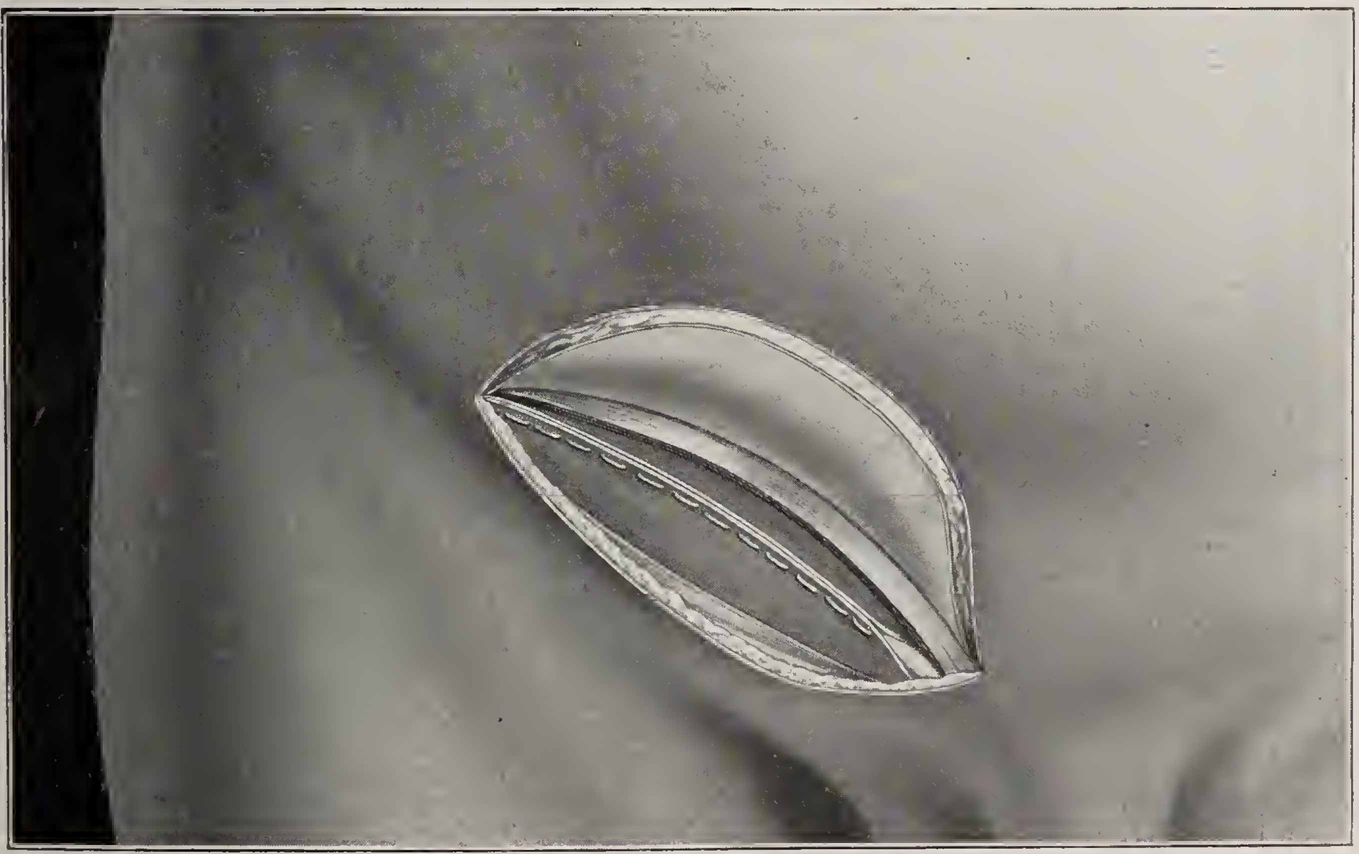

FIG. 544.—INTRAPERITONEAL DISPLACEMENT OF THE CORD.
The cord placed in the peritoneal cavity and the gap sutured.

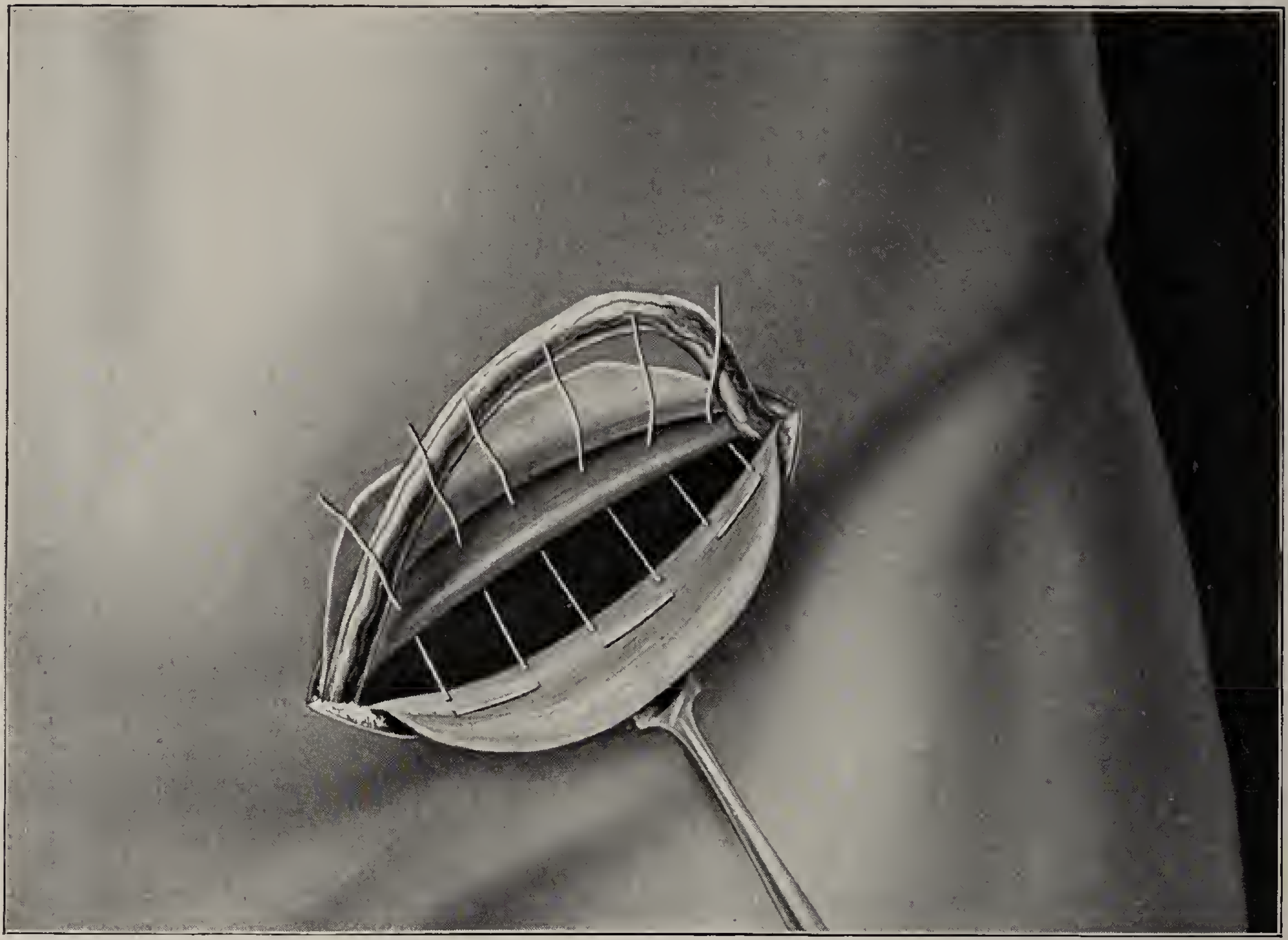

Fig. 545.—Operation for Inguinal Hernia.
First step of closing the canal by the method of imbrication. Suture of Poupart's ligament to the conjoined tendon.

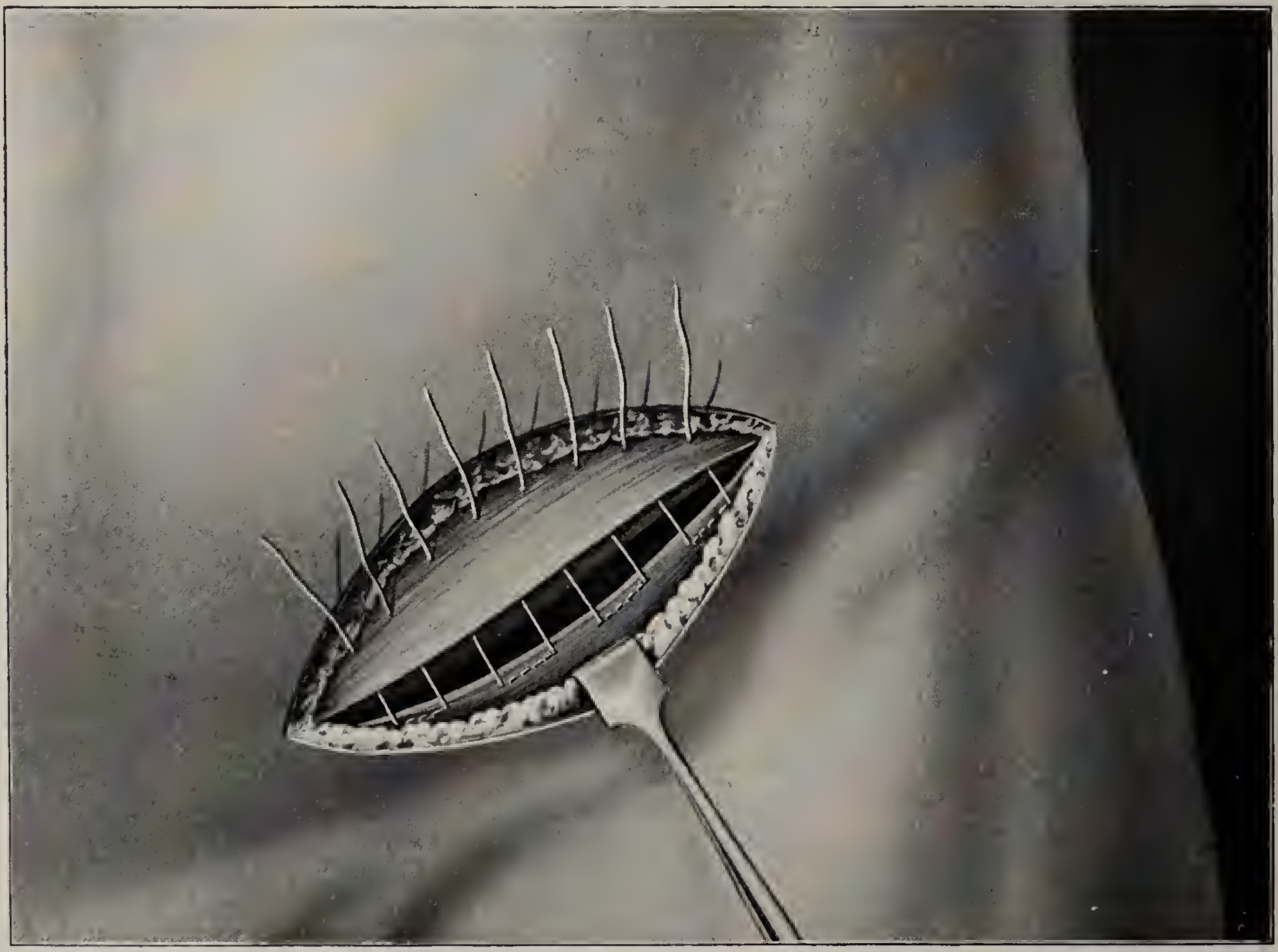

Fig. 546.—The Radical Cure of Inguinal Hernia. Anterior Displacement of the Cord, with Imbrication of the Aponeurosis of the External Oblique.
The free edge of the aponeurosis at Poupart's ligament passed in front of the cord and behind the aponeurosis of the external oblique in the direction of the median line.

tress sutures (Fig. 546). These latter may be of silver wire, the twisted and rolled-up ends of which should be *behind* the aponeurosis, not *in front* of it. If kangaroo tendon or chromicized catgut is used, the knotted ends may be placed on either side of the aponeurosis. The free edge of the aponeurosis left is now lapped or folded over the portion which has just been made to cover in the cord, and sutured with chromicized catgut well down on Poupart's ligament (Fig. 547).

My preference for this modification of the Bassini operation is based on the following: (1) a double layer of aponeurosis is placed in front of the newly formed canal and cord, instead of an unstable line of cicatricial tissue uniting the edges of a single layer; (2) the method permits the use of silver wire sutures in the aponeurotic structures, where they may be used to advantage, and affords an opportunity for covering in the twisted ends of the silver wire, or the knotted ends of buried silk sutures, if this material is used.

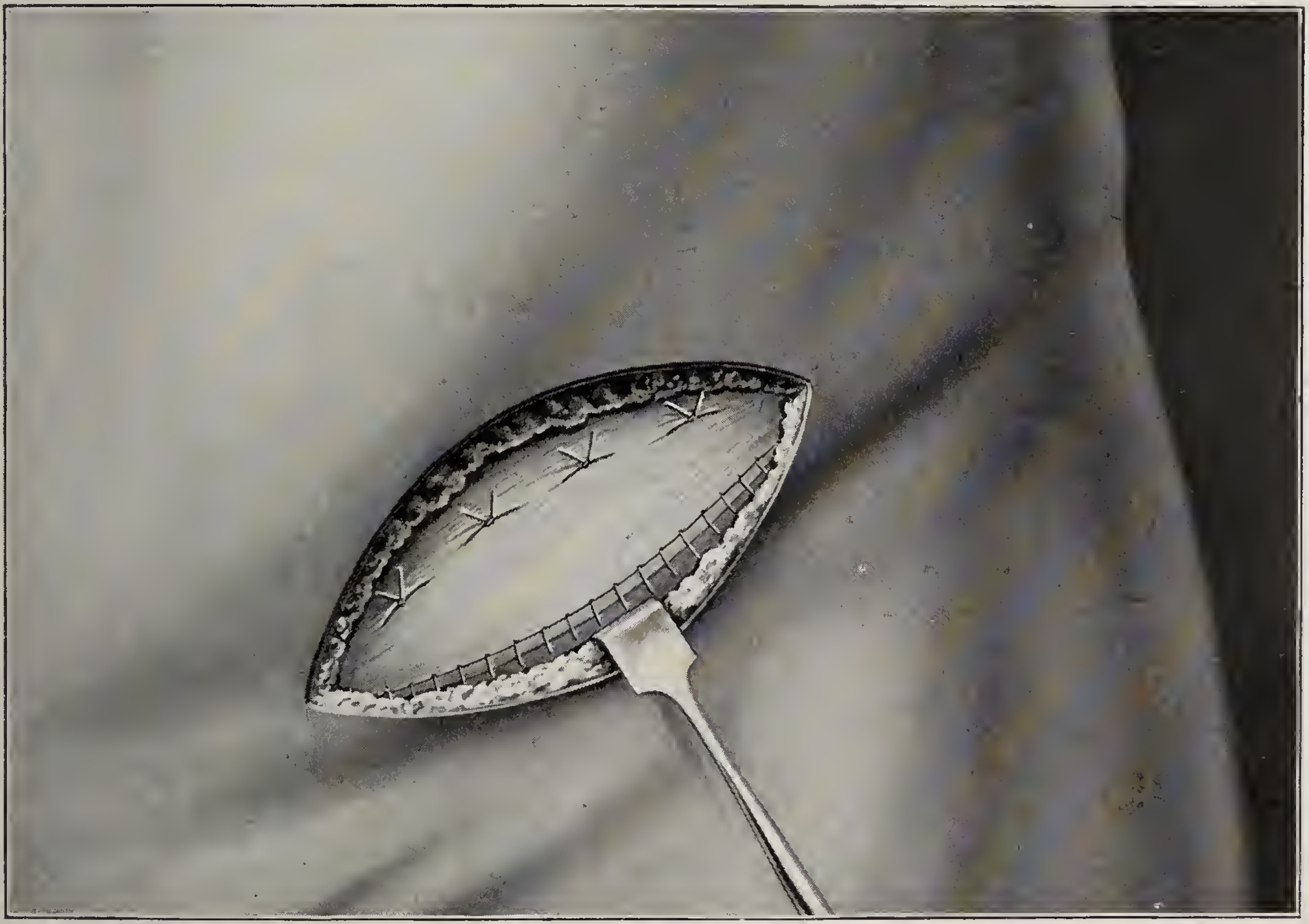

Fig. 547.—The Radical Cure of Inguinal Hernia. Anterior Displacement of the Cord, with Imbrication of the Aponeurosis of the External Oblique.
The completion of the imbrication, and suture of the aponeurosis in position over Poupart's ligament.

Suture Materials for Hernia Operations.—When carefully selected and properly sterilized **kangaroo tendon** can be obtained, it is to be preferred for suture material for the deep layer of sutures. The tendon, which should be uniformly smooth and sufficiently pliable to tie easily, should be prepared as follows: Each tendon is carefully and thoroughly cleansed by means of a stiff brush and green soap and warm water. Repeated rinsings in sterile water follow, after which the material is thoroughly dried, and boiled in absolute alcohol for one hour on three successive days. When ready for use, if the strands are found to be stiff or hard they are soaked in a 1 : 1000 solution of mercuric chlorid.

In the absence of kangaroo tendon **chromicized catgut** may be employed. The catgut is boiled in absolute alcohol for an hour on two successive days, soaked in a 1 : 5000 solution of chromic acid for twelve hours, dried, and boiled again for an hour in alcohol.

Sterilized iron-dyed silk may be used if neither of the above is at hand. This should be boiled for half an hour in a 0.6 per cent solution of common salt and then transferred to a 1 : 500 alcoholic solution of mercuric chlorid. The silk employed should be as fine as possible compatible with the strength required. Coarse silk is more difficult to sterilize, and its presence in the tissues, even when sterile, will set up irritation and favor suppuration.

When the operation of anterior displacement of the cord with overfolding of the aponeurosis of the external oblique is employed, silver wire may be used in suturing the free edge of Poupart's ligament to the posterior surface of the aponeurosis (*vide supra*). It should not be employed in the first layer of sutures, namely, those which secure Poupart's ligament to the conjoined tendon, for the reason that its presence in muscular structure leads to irritation and degenerative changes in the latter. Whenever employed, the twisted ends of the wire should be covered by a layer or fold of the aponeurotic or fascial structure which it unites.

The superficial sutures should be of catgut prepared as above, or simple catgut prepared by fractional sterilization, as recommended for kangaroo tendon. The skin sutures may be interrupted, if of silkworm-gut, or the chain stitch or subcuticular method employed, if of linen thread or silk.

Confinement to bed should be extended over a period varying from two to three weeks, according to the nature of the case and the course pursued by the healing process. The patient may be permitted to walk about a week after he is allowed to be up, and may resume his usual work, if this is not of a laborious nature, from two to four weeks later. While early walking about favors the muscular tone of the abdominal walls, too early resumption of an occupation of an arduous nature favors a return of the hernia.

The **general after-treatment** of the case should be carried out on the usual lines of a peritoneal section (see page 31).

The **wearing of a truss** after the operation is uncalled for, except in exceptional cases. These include (1) cases in which suppuration occurs; (2) cases in which the hernia was acquired and of long standing, with greatly dilated apertures and atrophied muscular and aponeurotic structures from truss pressure; (3) cases in which the subjects have excessively fat, overhanging, or bulging abdominal walls, particularly where they are compelled to follow some laborious occupation; (4) cases of women during pregnancy or parturition; (5) cases in which the operation follows herniotomy for strangulation; (6) following operation in certain cases of direct inguinal hernia (see page 187).

Exercises which tend to favor muscular development of the abdominal wall should be encouraged after convalescence is completed.

Complications Met with and Precautions to be Taken in the Operation for the Radical Cure of Inguinal Hernia.—The superficial epigastric artery, and sometimes the superficial external pubic vessels, are encountered in the division of the skin and superficial fascia. These should be ligated in two places and cut between the ligatures.

When necessary to effect division of the aponeurosis of the external oblique, this must be made strictly in the line of its fibers, and all unnecessary injury to this important structure avoided. On no account should its cut edges be grasped by pressure forceps.

In dealing with congenital hernia in young subjects, difficulty is sometimes met with in the separation of the neck of the sac from the cord. If this is not properly done, the vas deferens may be included in the ligature thrown about the neck of the sac. More frequently, however, a vessel is torn across in the effort to effect the separation, and some difficulty is encountered in arresting the bleeding. Infiltration of the loose connective tissue in this region must be avoided as far as possible. The bleeding point is usually deeply situated, but by drawing the fibers of the internal oblique and transversalis muscles upward and outward and the neck of the sac well forward, it can be secured. These fibers should never be divided, since their presence intact is quite essential to the success of the operation.

The body of the sac is sometimes so intimately blended with the structures of the cord as to render its recognition difficult. By placing the parts on the stretch and holding them up to the light, the line of separation may be recognized.

In the case of a completely or partially irreducible hernia, care must be taken in opening the sac not to injure its contents. The irreducible portion, which is usually omentum, is gently separated. If the adhesions are thick, they should be tied off and divided. The separation should be carried well beyond (posterior) to the deep ring. If large masses of omentum are present these should be treated by multiple ligation and excision in the manner shown in Fig. 414. The raw edge left after the excision of the omentum should be rolled under and secured by a few catgut sutures to prevent subsequent adhesions to intestine and obstruction by strangulation (see page 32). The stump should be carefully inspected for bleeding vessels before being returned.

Adhesions between intestine and sac or between intestine and omentum must be separated with great care. In effecting this, in case of old and dense adhesions, it is better to leave a portion of the sac wall adherent to the gut than to risk tearing the latter. Injury to the intestinal wall must be at once repaired with a few Lembert sutures of very fine silk. In **"sliding hernia" (congenital cecal hernia)** great difficulty is sometimes encountered on account of the absence of the normal serous covering. In these cases the peritoneum may be divided behind the adherent intestine and the latter raised and replaced within the abdomen. The resulting gap in the peritoneum may then be sutured.

Hernia of the bladder may complicate the operation. The presence of lipomatous masses should lead to the suspicion that these arise from the perivesical fat, producing a hernia of this viscus. The bladder will, as a rule, form part of the wall of the sac in such a case, and without due care a portion of its wall will be included in the ligature. In addition to the lipomatous masses, this complication may be suspected if there is an unusual thickening of the sac at its upper and inner portion, or if unstriped muscular fibers are present. If the complication is discovered at once, the peritoneum covering the bladder should be carefully incised and the latter freed from the remainder of the sac wall. The bladder itself is then reduced. If the opening left extends beyond the limits of the sac, the gap left in the parietal peritoneum may be closed by suture.

If the vermiform appendix is found in the sac, typic excision of the organ should be performed.

The **ovary** may be protruded either alone, in connection with its Fallopian tube, or together with other viscera. The condition may be either congenital or acquired. If the ovary is in a healthy condition, it should be returned; otherwise it should be removed.

If difficulty is experienced in drawing the neck of the sac well forward, and if considerable tension must be exercised on the latter in order to bring it readily within reach, slipping of the ligature may be guarded against by transfixing the sac with two ligatures, interlocking these, and ligating the sac in two halves. The free ends of one of the ligatures are now tied securely around the entire neck.

If, after the sac is cut away, the stump does not retract behind the arching fibers of the conjoined tendon, owing either to excessive dilatation of the hernial aperture or to faulty development of the fibers themselves, the surgeon should draw it well above the site of the deep ring and to the outer side of it by passing the ends of the ligature on the neck, left long for the purpose, through the transversalis and internal oblique muscular fibers at two separate points, about half an inch apart, and tying them. An excessively large sized opening requires suture of the mouth of the sac instead of ligature; the body of the sac which, under these circumstances, is usually strongly adherent and lies in the direction of or entirely within the scrotum, may be disregarded.

In infants and young children the upper one or two of the deep sutures introduced, or those which include the arciform fibers and diminish the size of the canal, should be tied cautiously, lest, by pressure, they destroy the action of these fibers. In fact, in this class of cases it may be better to omit this deep row altogether, as already stated. In neglected congenital hernias, however, the action of these fibers has been destroyed, and in acquired hernias it has not been efficient in preventing the hernias; developmental failure of the fibers themselves may have been a cause of its occurrence. In either case the closest suturing of the canal compatible with the avoidance of undue pressure on the cord offers the only means of correction of the existing conditions, if the method of typic restoration of the canal is followed. In females close suturing may be accomplished without reference to the contents of the canal, the upper suture crowding closely the internal, and the lower one or two obliterating the external ring completely.

In passing the sutures through the portion of the external oblique known as Poupart's ligament, care should be taken to include this only and thus avoid injury to the femoral vessels. In large indirect inguinal hernias the effort is sometimes made to include the outer edge of the rectus in the lower one or two of the deep row of sutures. This is not often accomplished without making undue tension on the sutures themselves; and when successful it cannot be considered as permanently efficient. Separation of the pubic attachment of the rectus to facilitate this technic has nothing to recommend it.

Direct Inguinal Hernia.—This form of hernia leaves the abdominal cavity through Hesselbach's triangle. Its protrusion involves the forward displacement of the parietal peritoneum constituting the sac, the extraperitoneal connective tissue and fat, the transversalis fascia, sometimes the conjoined tendon, the intercolumnar fascia, the superficial fascia, and the skin. These in their reverse order constitute the coverings of the hernia. The direct form constitutes about 7 per cent of the cases of inguinal hernia. It is always an acquired hernia and occurs almost exclusively in males. It presents itself as a rounded or globular protrusion at the inner part of the inguinal region, occurs most frequently on the right side, and is more frequently double proportionately than is the indirect form.

In the diagnosis of this form of hernia inspection shows the long axis of the swelling to be parallel to the linea alba. Invagination of the scrotum by the finger reveals the absence of a posterior wall of the canal. Occasionally the pulsation of the deep epigastric artery may be felt to the outer side of the neck of the hernial sac. The spermatic cord is never so intimately associated with the hernia as in the indirect variety, but is situated at first external to it and then behind it. The outer edge of the rectus is felt to be unusually prominent, as compared with the other side, particularly if the patient lies on the back and raises the lower extremities, with the knees extended.

Strangulation occurs with comparative infrequency in this variety of hernia. On the other hand, considerable difficulty is encountered in retaining it by means of a truss, and it is not so amenable to cure by operation as indirect inguinal hernia.

Treatment.—In the nonoperative treatment an ordinary inguinal truss with the extra cushion as for scrotal hernia should be applied. The addition of an extra cross-strap is usually necessary (Fig. 535).

In the radical operation for the cure of a direct inguinal hernia the same steps are necessary for the indirect form up to the point of dealing with the sac. In cases of large protrusion it is advisable to remove this flush with the general cavity of the abdomen and close the resulting gap with a pursestring suture. A small sac may be closed by ligature. The conjoined tendon, usually displaced upward and inward, and sometimes imperfectly developed or atrophied from prolonged pressure, is then sutured to the inner part of Poupart's ligament, with the cord in front. If, as sometimes occurs, the protrusion has taken place through a rent or slit in the tendon itself, this will require separate suturing.

Of the relapses following the radical operation for inguinal hernia, the larger number occur in direct inguinal hernia. In view of this, and particularly in cases where the protrusion is large and of long standing, a truss should be worn for several months afterward.

Interstitial Inguinal Hernia.—In this variety the sac lies in one or the other of the planes of the abdominal wall, namely, first in frequency between the external and the internal oblique muscle; second, between the aponeurosis of the external oblique and the skin; third, between the transversalis fascia and the peritoneum (**"properitoneal hernia"**). In males this form is commonly associated with ectopic testicle, the latter probably taking part in the causation. Repeated forcible efforts at reduction of an ordinary inguinal hernia may lead to its production. It is most frequently found on the right side.

In all cases there is a primary sac and a superadded diverticulum, or secondary sac. The former lies in the usual position, either in the inguinal canal or in the scrotum, while the latter constitutes the interstitial portion of the hernia.

In the cases in which the sac lies between the external and the internal oblique muscle, the diverticulum usually passes in an upward direction and presents itself as an oval flattened swelling lying parallel to Poupart's ligament; or it may pass downward into the scrotum. In the variety in which the sac lies between the aponeurosis of the external oblique and the skin, the development of an interstitial sac is more likely to be preceded by a scrotal hernia. The diverticulum likewise moves upward and outward, appears as a more pronounced swelling, and may become sufficiently large to overhang Poupart's ligament, thus simulating a femoral hernia. Properitoneal hernia is rarely recognized during life, except in the course of an operation. A portion of the sac occupies the scrotum or labium. There is but slight if any external swelling, the sac lying in the extraperitoneal tissue of the iliac fossa, or behind the pubis. When irreducible or strangulated, it is particularly liable to be reduced *en masse* during taxis, the scrotal or labial portion of the hernial contents being forced into the diverticulum, the symptoms, in case of strangulation, persisting.

In the **treatment** of interstitial inguinal hernia the condition when recognized constitutes a positive indication for an attempt at radical cure. Even when unsuccessful in this regard at first, the dangerous diverticulum or secondary sac is destroyed, leaving an ordinary hernia to be dealt with subsequently either by another operation or by a truss.

FEMORAL HERNIA

A protrusion through the femoral ring and the femoral canal is called a femoral hernia. The **femoral ring** is situated behind the innermost part of Poupart's ligament, a little below and external to the spine of the pubis. It is bounded internally by the triangular internal attachment of Poupart's ligament, known as Gimbernat's ligament; externally by the femoral vein; in front by Poupart's ligament and a thickened portion of the transversalis fascia; behind by the pectineus muscle and Cooper's fascia; and above by a layer of extraperitoneal tissue, called the septum crurale.

The so-called **femoral canal,** into which the femoral ring opens, is really only a space, somewhat triangular in shape, which constitutes the most internal division of the femoral sheath. This internal division of the femoral sheath normally transmits lymphatic vessels, passing from the superficial to the deep lymphatic glands, incloses cellular tissue and fat, and sometimes a lymphatic gland. The external division carries the femoral artery and the middle division the femoral vein. The femoral canal or space is bounded externally by the septum separating it from that carrying the vein, and internally by the junction of the iliac fascia with the fascia transversalis. The fascia transversalis and the fascia iliaca bound the space respectively anteriorly and posteriorly. The entrance to the space is the femoral ring and its exit or lower aperture is the so-called saphenous opening.

The **saphenous opening** is situated between the anterior and the posterior layer of the fascia lata, known as the iliac and pubic portions of the latter, and lies at the upper and inner part of the thigh. It is oval in shape, with the long axis directed downward and outward, and transmits the internal saphenous vein. The outer edge of the opening is on a plane anterior to the inner edge and has its upper portion attached to the anterior surface of Gimbernat's ligament, while its lower extremity constitutes the point of junction of the two portions of the fascia lata which form the openings. The inner edge of the opening is much less sharply defined than the outer. The opening itself is covered in by a part of the deep layer of the superficial fascia of the thigh, named, because of numerous small openings in it for the passage of vessels, the cribriform fascia.

The occurrence of a femoral hernia involves the forward displacement of the following: (1) the sac wall proper, made up of the peritoneum; (2) the extraperitoneal connective-tissue layer, including the septum crurale; (3) the transversalis fascia, derived from the wall of the canal itself; (4) the cribriform fascia; (5) the superficial fascia; (6) the skin. These structures, mentioned in reverse order, constitute the **coverings of the hernia.**

After entering the femoral canal, the sac of the hernia passes in an upward direction on the inner side of the femoral vessels and lies with its neck to the outer side of the pubic spine and internal to the deep epigastric artery, the latter, as well as the spermatic cord in the male, lying on a high level.

Causes of Femoral Hernia.—This form of hernia is never congenital and rarely occurs before the age of puberty. It occurs more frequently in females and most commonly in those who have borne children. Femoral hernia, however, is not more common in women than is inguinal hernia. The femoral ring is said to be proportionately larger in women than in men, owing to the slighter development and not infrequent absence of Gimbernat's ligament.

Symptoms of Femoral Hernia.—The presence of a femoral hernia may be frequently overlooked, owing to its insidious development. It is particularly liable to occur in obese women. In men it is likely to be mistaken for an inguinal hernia. The local distress incident to the development of an inguinal hernia is seldom present in femoral hernia, hence the necessity for careful examination of this locality in intestinal obstruction.

The protrusion itself may be first discovered as a rounded or distinctly globular swelling below the inner extremity of Poupart's ligament. Or, at a later period, having passed the confines of the femoral canal, it may either appear on a lower level on the thigh, or ascend in a vertical direction in front of Poupart's ligament. In the last-named position it may be easily mistaken for an inguinal hernia. The differentiation is still further embarrassed in the cases in which the protrusion passes obliquely upward and outward toward the anterior superior spinous process of the ilium.

In the **diagnosis of reducible femoral hernia** care must be taken to distinguish this from (1) reducible incomplete inguinal hernia, or bubonocele; (2) a saphenous varix; (3) a psoas abscess pointing in the thigh. In differentiating a reducible inguinal hernia from a reducible femoral hernia the chief point to be relied on is the position of the hernia, which in the first-named is entirely above Poupart's ligament and in the second entirely below that structure. Reduction is effected in femoral hernia in a direction upward and backward and in inguinal hernia outward, upward, and backward. A saphenous varix is always below Poupart's ligament, but never in front of it, is not elastic as in the case of a femoral hernia, and, unless the seat of a thrombus, has not a solid feel. Impulse on coughing is absent, and is replaced by a fluid thrill-like sensation or a distinct "purr." Fluctuation is present except in the event of a solidification following a thrombophlebitis due to an attempt to wear a truss, or to other causes. The percussion-note is dull and on auscultation none of the gurgling sounds heard in hernia when intestine is present is perceived. Finally, other varicose veins may be present (Fig. 548). In psoas abscess the protrusion may be either below or above Poupart's ligament, is usually elastic, but the impulse on coughing, while expansile, is not well marked. Fluctuation is usually distinct, the percussion-note is always dull, and gurgling is never heard on auscultation. Finally, the presence of Pott's disease may almost always be made out.

In the **diagnosis of irreducible femoral hernia** the presence of enlarged lymphatic glands is the most frequent, as well as the most important, source of error. Incision of a hernia for a mass of suppurating lymphatic glands is a not infrequent and fatal error. Fatty tumors, or lipomas, are not infrequently found in this region. These are more frequently situated external to the femoral vessels, have no impulse on coughing, and are comparatively movable and superficial. Fibromas, bursal tumors, cysts, exostoses, and aneurisms are rarely observed as compared with hernias and lipomas in this locality, and when present are usually easily distinguished.

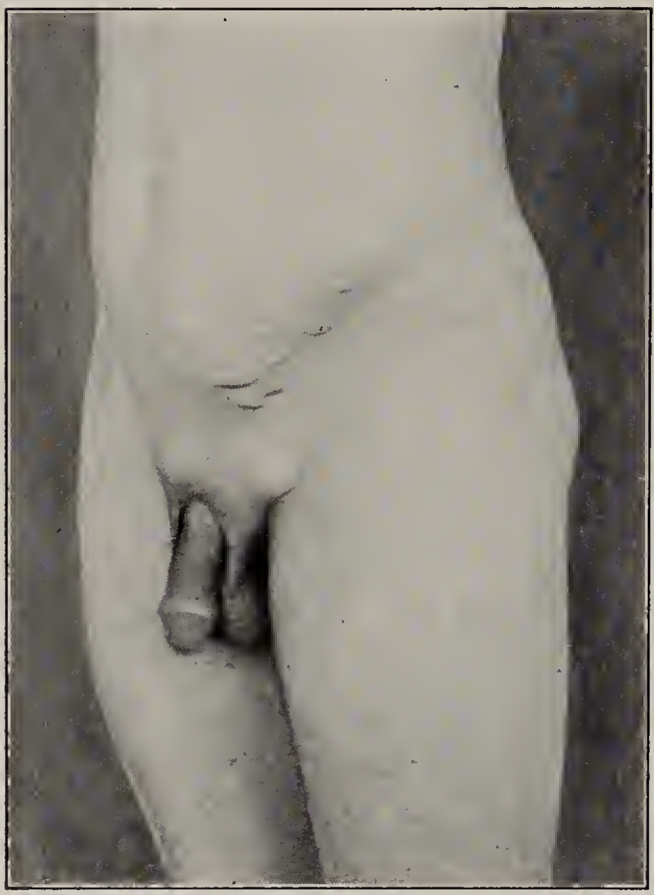
FIG. 548.—SAPHENOUS VARIX SIMULATING FEMORAL HERNIA.

Hydrocele of the sac may be present in a femoral hernia in which the contents are almost, but not entirely, reducible. This is due to the presence of a small portion of adherent omentum with a free extremity. The latter acts as a ball valve in closing the orifice of the sac, while the accumulation of serous fluid gives rise to the so-called hydrocele.

The Treatment of Femoral Hernia by Trusses.—A small and easily reducible femoral hernia can usually be efficiently controlled by a suitable and properly applied truss, constructed on the same general principles as an inguinal truss. The pad, however, is smaller, and the position of the spring circle to which it is attached is fashioned in such a manner as to pass more obliquely downward and inward than in the inguinal truss. The lateral attachment of the perineal straps is more distinctly toward the front, or beneath the site of the anterior superior spine of the ilium and anterior to it (Fig. 549). The method of measurement differs in no respect from that of an inguinal truss. In larger hernias the pad is made fuller and is prolonged vertically downward by extending the limits of the soft or cushioned portion. The latter is somewhat pointed, to fit in the hollow of Scarpa's space, and is prevented from slipping by a padded thigh belt attached to the pad. The thigh belt then passes around the thigh, and is secured in place by two straps, one to the metal portion of the pad and one to the frame of the truss slightly behind the first. The thigh belt is adjusted first and the perineal strap applied afterward (Fig. 550).

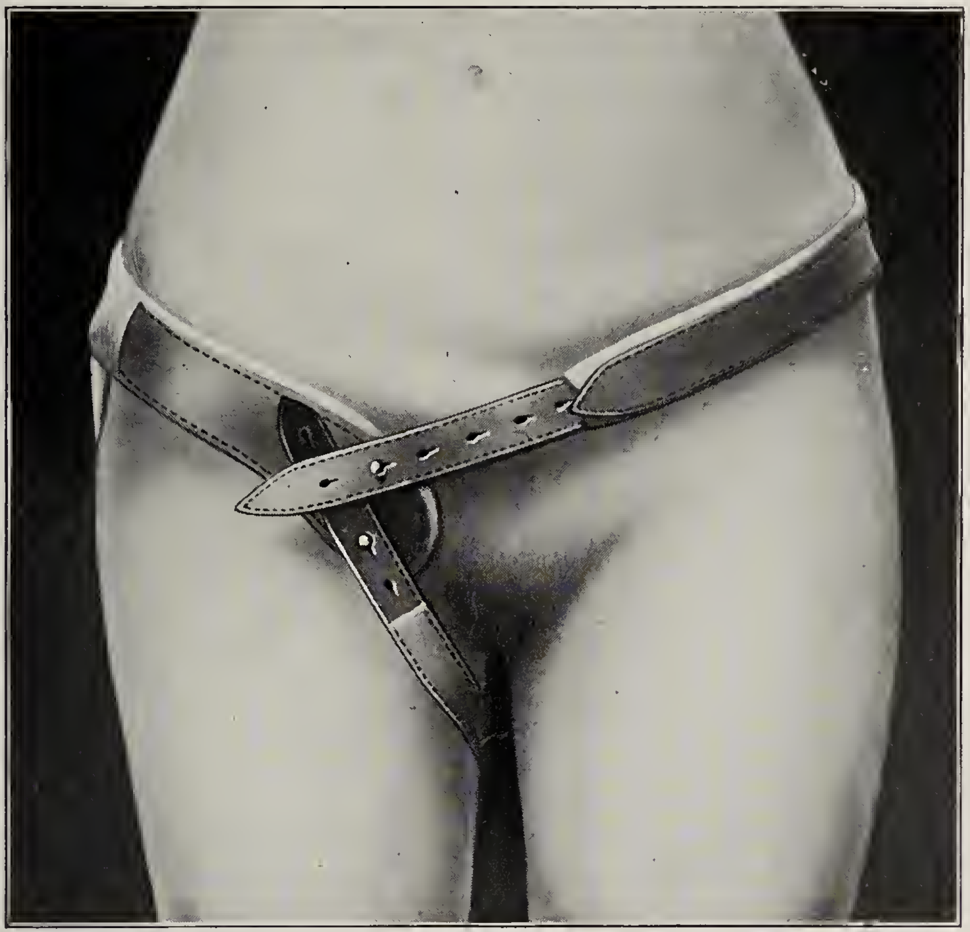

Fig. 549.—Single Right Femoral Truss Applied.

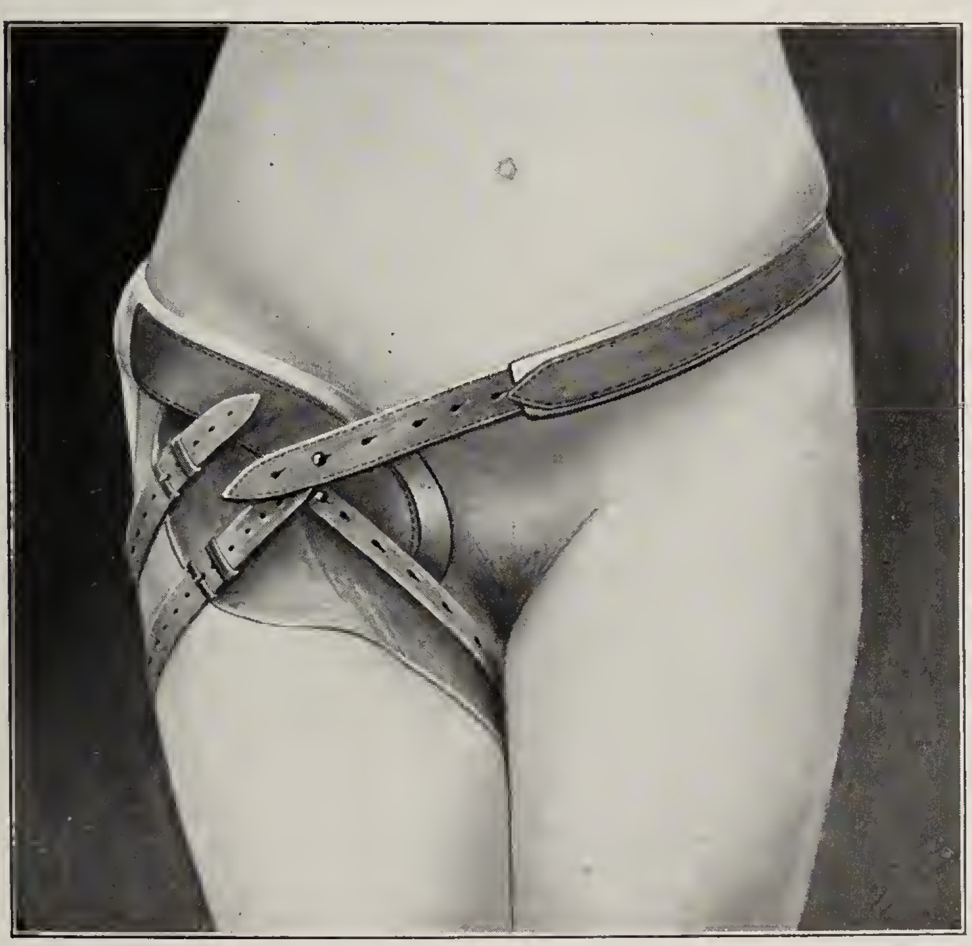

Fig. 550.—Right Femoral Truss with Thigh Belt Applied.

Irreducible femoral hernia is a condition demanding operative treatment whenever this can be carried out without undue danger to life.

In the isolated and rare instances in which the irreducible portion of the hernial mass remaining in the sac is small and made up exclusively of omentum, an ordinary femoral truss with a slightly concave pad may be applied with the hope that this may finally effect complete reduction. The pad itself should be gradually changed from a concave to a convex shape. If the irreducible mass is large, the pad should be distinctly hollow, with an inguinal fullness and a thigh-belt added to the truss.

The Operative Treatment of Femoral Hernia.—The **method of Fabricius** for the radical cure of femoral hernia, as employed by me, consists of the following steps: (1) the incision is planned so as to expose that portion of the aponeurosis of the external oblique known as Poupart's ligament at the pubic spine, the line where the latter blends with the fascial structures of the thigh, and the sheath of the vessels at the femoral opening; (2) the sac of the hernia is exposed and cleared to its neck; (3) the sac is opened, emptied, and ligated at its neck; (4) the edge of the aponeurosis of the external oblique is forced backward to the level of the upper margin of the horizontal ramus of the pubic bone and there sutured to the periosteum and the origin of the pectineus muscle. By this means the femoral space or canal is obliterated.

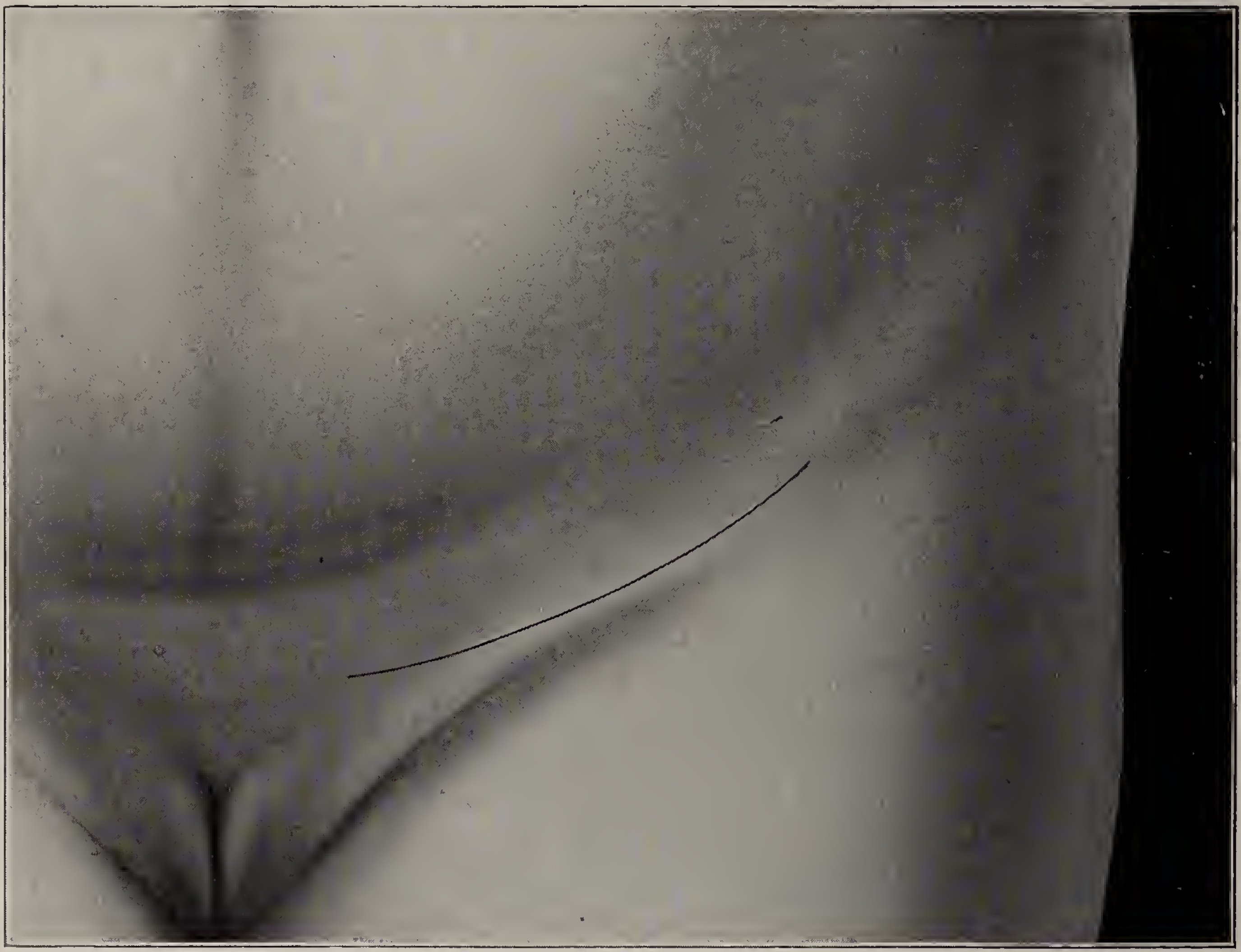

Fig. 551.—The Fabricius Operation for the Radical Cure of Femoral Hernia. The Line of Incision.

The patient is placed in the Trendelenburg position. The incision commences at the spine of the pubic bone and is carried parallel to Poupart's ligament for a distance of about four inches, extending well beyond the femoral vessels (Fig. 551). The hernial sac may project directly beneath the lesser falciform process and come into view at this stage of the operation. In other cases, however, it lies beneath the superficial layer of the deep fascia of the thigh and is covered by the cribriform fascia.

After the sac is exposed and thoroughly isolated it is opened. The sac is now drawn forward, emptied of its contents, its neck ligated, and the ligated portion of it cut away (Fig. 552). In order to expose more freely the femoral canal preparatory to its obliteration, the attachment of Poupart's ligament at the pubic spine is first detached and the separation carried on in an outward direction until this structure is separated from the superficial layer of the fascia lata up to the femoral sheath. Though this layer of the deep fascia is somewhat tense at the latter point, yet it does not lie directly on the vessels. With the index-finger introduced to guard the latter, the separation of the fascia lata from Poupart's ligament is completed with the scissors and the former structure reflected in a downward direction (Fig. 553). The femoral canal thus exposed contains the ligated neck of the sac, some fatty and areolar tissue, and one or two lymphatic glands. The latter are to be removed, and the former, together with the peritoneum, loosened in all directions.

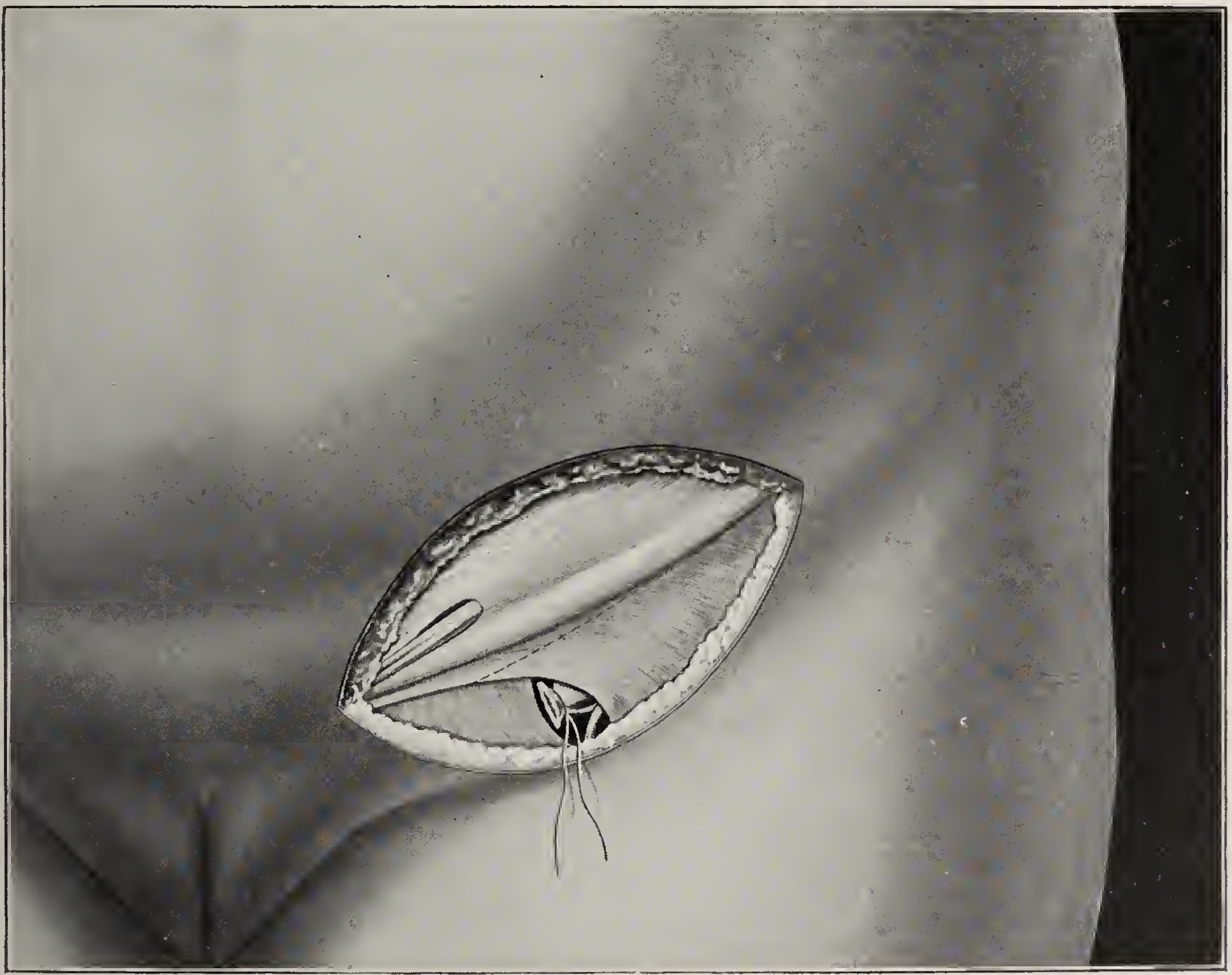

Fig. 552.—The Fabricius Operation for the Radical Cure of Femoral Hernia. The appearance of the parts after cutting away the sac. The dotted line shows separation of Poupart's ligament and fascia lata.

The essential and important step of the operation consists in attaching Poupart's ligament to the point of origin of the pectineus muscle and the periosteum of the horizontal ramus of the pubes. By this maneuver

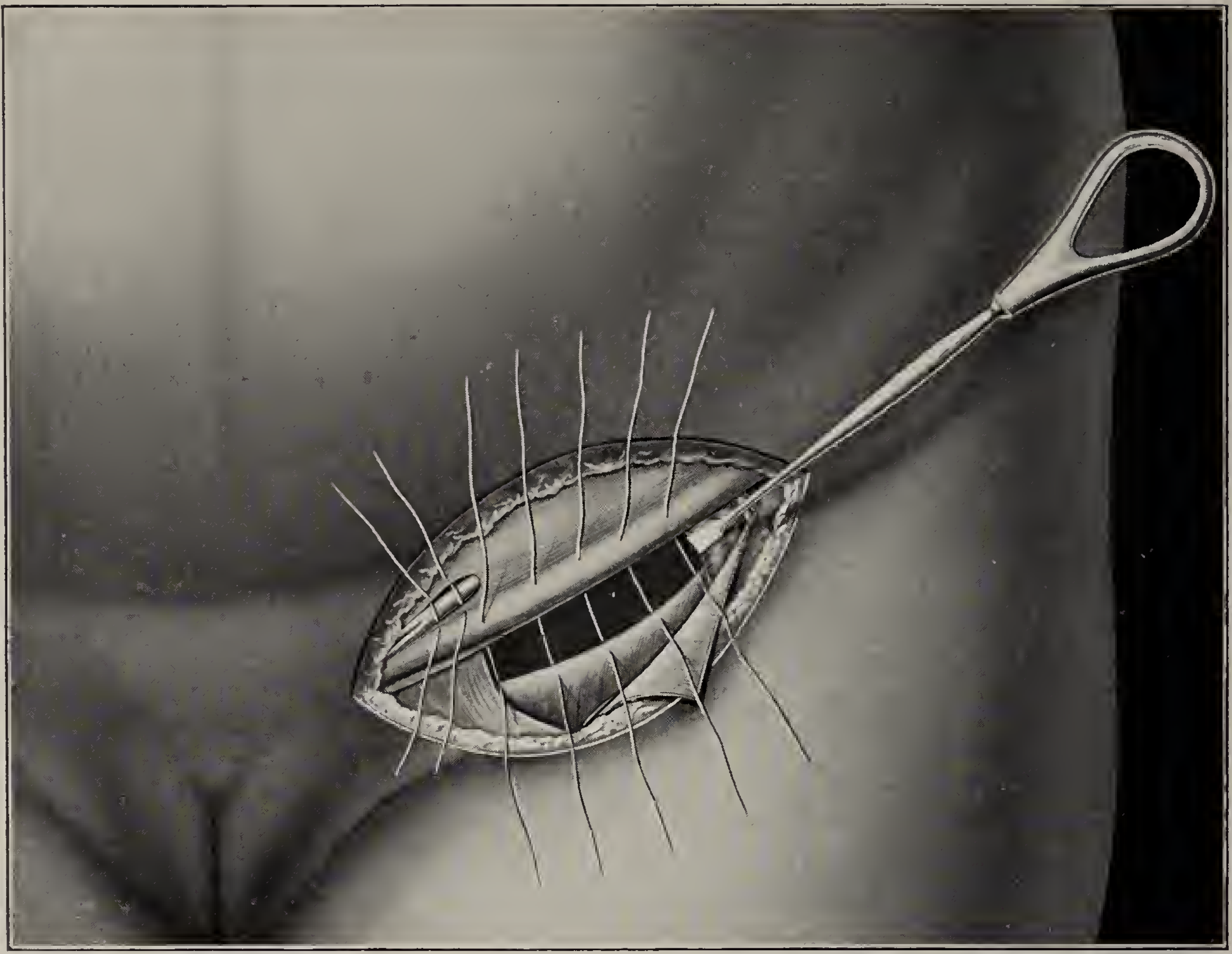

Fig. 553.—The Fabricius Operation for the Radical Cure of Femoral Hernia. The fascia lata turned down, showing origin of the pectineus. The vessels are retracted and sutures passed ready for tying. Two sutures are placed in position for the approximation of the external ring.

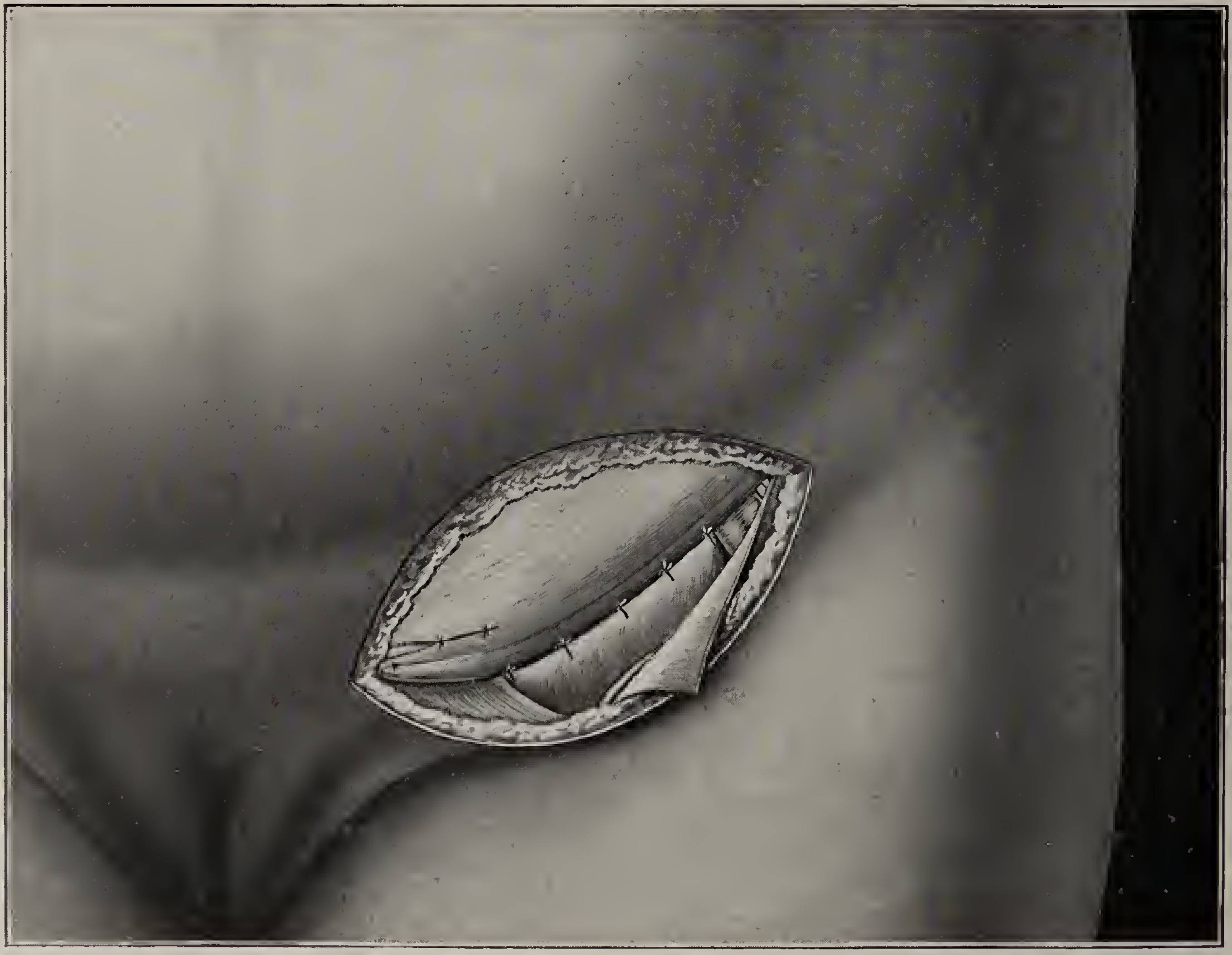

Fig. 554.—The Fabricius Operation for the Radical Cure of Femoral Hernia. The Sutures Tied.

Poupart's ligament is made to describe a backward curve, following the recession of the bone at this point and imitating in this respect that portion of the same structure which is reflected obliquely outward and backward after its insertion into the pubic spine, and is known as Gimbernat's ligament. In this manner the femoral canal or space, which normally lies between Poupart's ligament and the bone, is obliterated. The femoral sheath and its contained vessels are displaced well to the outer side, and above the iliopectineal eminence, and there held during the suturing, in order to make available an increased area for the attachment of Poupart's ligament to the horizontal ramus of the pubes (Fig. 553). The periosteum and bony attachment of the pectineus to the extent of at least half an inch must be caught up by the needle each time it is passed in order to effect a firm attachment for Poupart's ligament in its new position. Care should be taken not to injure the obturator artery and vein. All the sutures are first introduced, the parts are cleansed, and each is separately and securely tied (Fig. 554). The superficial layer of the fascia is now to be sutured to the aponeurosis of the external oblique and the remainder of the wound closed.

In aseptic cases no truss need be worn after the operation.

UMBILIC HERNIA

Umbilic hernia is a protrusion at the site of the original attachment of the umbilic cord and the aperture for the passage of the umbilic vessels. After the falling of the cord and the obliteration of the vessels, the opening is closed by scar tissue. In the infant an arrangement of fibers of semielastic tissue surrounds the site of the opening in the form of a sphincter, which finally becomes fibrous and contracts on the structures which originally passed through the opening. The so-called umbilic ring is formed by two sets of fibers, one of which encircles the site of the original aperture, while the other passes across the middle line. The scar tissue which marks the site of the obliterated urachus and umbilic arteries is placed in the lower portion of the opening, while the remains of the umbilic vein occupy the upper portion. Hence the latter is less firm than the former.

Umbilic hernia may be classified as congenital, or true omphalocele, and acquired. The acquired form may be subdivided into those occurring in infantile life, and those occurring in adult life.

Congenital umbilic hernia or omphalocele is the result of a failure of development and may be compared to a spina bifida. The failure of the anterior abdominal wall to close at the umbilic region results in a deficiency at this point, which permits the abdominal viscera to push forward the base of the cord; the latter becomes saclike and distended. The protrusion may vary in size from a small sacculation to a wide gaping in the middle line of the abdominal wall. The hernial covering consists of the amniotic layer of the cord, through which the contained viscera may be frequently seen. The omphalocele may be accompanied by arrest or errors of development of the intestinal canal itself, or of other structures.

The **treatment** of omphalocele consists of the most rigid care to prevent ulceration of its coverings, the occurrence of which will lead to fatal peritonitis. A ring-shaped compress should be applied, with the stump of the cord projecting through the ring. This may be kept in place by collodion, supplemented by adhesive plaster and a bandage. In favorable cases there is a tendency for the abdominal walls to close in upon the opening, and a permanent cure is thus effected. When this does not take place, at a later period the sac wall may be removed and the opening closed by suture. If ulceration threatens or an intestinal malformation leading to obstructions exists, this operation should be performed at once, the malformation being corrected by a suitable enterorrhaphy. In cases of large omphalocele with eventration (**ectopia viscerum**), a divided symphysis and even extroversion of the bladder (**ectopia vesicae**) may coexist and require a more extensive operation. If the surgeon succeeds in reducing and maintaining the ectopic viscera by a plastic operation, the extroversion of the bladder may be dealt with later on. The prognosis in this class of cases is always grave and frequently hopeless.

Acquired Umbilic Hernia.—In the **infantile variety** of this form of umbilic hernia a true hernial sac is formed by intra-abdominal pressure during the first few months of life, the cicatricial tissue at the site of the cord becoming greatly thinned and stretched. Straining from constipation or phimosis, and traction on a short cord either before or after birth are the exciting causes. The hernia appears as a conic or cylindric protrusion, which increases in size when the child cries or strains. It usually contains intestine, though omentum may also be protruded. Strangulation is very rare and spontaneous cure the rule.

Treatment.—Errors of diet causing constipation should be corrected, and phimosis should be cured by breaking up adhesions at the balanopreputial fold, or by circumcision. In order to hasten the cure of the hernia an umbilic belt may be worn. This should be fitted with a flat pad. A conic or round projection made to fit into the umbilic ring will only prevent the natural process of cure by closure of the aperture and should be discarded. A simple pad of soft gauze or lint placed in the middle of a strip of adhesive plaster makes an excellent retentive apparatus. In the application of this, the pad is placed in position, the two halves of the abdominal wall brought together by the fingers and thumb of the surgeon's left hand so as to approximate the edges of the opening, and while so held, the adhesive plaster is adjusted.

Acquired umbilic hernia in the adult is most common after twenty-five and is confined almost entirely to females. The deposits of large amounts of fat in the omenta and mesenteries, and pregnancy, are the chief causes. The protrusion occurs at the umbilic ring, as in infants, but usually pushes forward on either one or the other side of the cicatrix. When the protrusion occurs exactly in the median line, it is more likely to have escaped through the linea alba, in which case it is not an umbilic but a ventral hernia.

Acquired umbilic hernia in the adult may assume enormous proportions and contain a large amount of omentum, and bowel as well. The entire transverse colon and the stomach may be found in the sac. The peritoneal portion of the sac becomes greatly thinned and in some instances fenestrated; this leads to the foundation of intercommunicating compartments, or loculi, in which intestine may become easily strangulated. Or, the bowel may be lodged in a secondary sac formed by omentum adherent to the peritoneal sac wall.

On inspection the hernia appears as a rounded or oval, somewhat pendulous and often lobulated swelling in the umbilic region. The lobulated projections may be tense and elastic, or hard and inelastic, according to whether they contain intestine or omentum. An expansile impulse may be present on coughing. A sense of heaviness and dragging, and sometimes actual pain, is present. Disturbances of function of the contained viscera, such as nausea, vomiting, constipation, or diarrhea, may occur.

Irreducibility is of early and frequent occurrence in this variety of umbilic hernia. Adhesions occur between the sac wall and its contents, or between different portions of the latter. The irreducibility is increased by further deposits of fat in the protruded omentum. Incarceration is somewhat frequent, from accumulation of feces in the contained large intestine, and strangulation, the prognosis of which is very grave, is not uncommon. The pressure of an ill-fitting truss, or even the friction of the clothing on the thinned coverings of the distended protrusion, leads to ulceration, with perforation of the sac and septic peritonitis. Spontaneous cure is exceedingly rare.

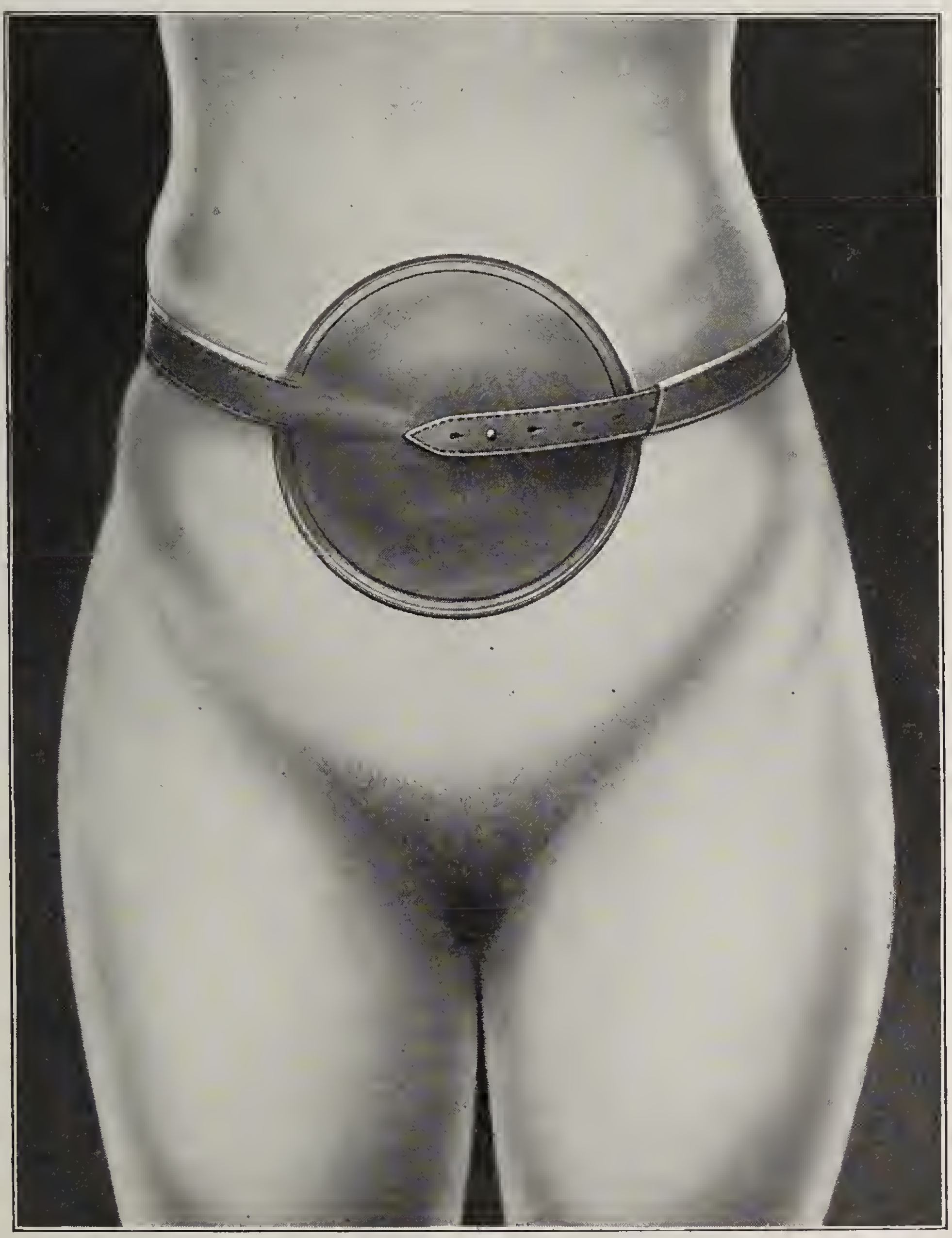

Fig. 555.—Umbilic Truss Applied.

Treatment.—When reducible, an umbilic hernia in the adult should be treated by the application of a suitable truss with the object of preventing the descent of fresh viscera. Such a truss should consist of a steel spring, made to encircle about three-fourths of the trunk, with a circular and slightly concave pad. This is held in place by a strap, which is a prolongation of the leather covering of the spring, fastened to a stud in the center of the pad (Fig. 555). The apparatus should be applied so that the upper edge of the pad corresponds with the upper margin of the hernial protrusion, when the patient is lying. In the erect position the falling forward of the abdominal wall will cause the pressure to be directed upward and backward. In excessively corpulent persons two broad pads will be necessary to prevent the truss from burying itself in the skin of the flanks and abrading it. In less obese subjects, and particularly in the case of men, a semicircular spring, with a pad on each end, the one pad resting on the spine and the other on the hernia, answers well. The spinal pad is the smaller of the two and a connecting strap between the two pads serves to maintain the apparatus in position. In cases of lax abdominal walls a closely fitting abdominal belt should be worn under the truss.

In no event should endeavors to lessen the amount of adipose tissue by careful dieting and other means be neglected in those disposed to obesity.

The palliative treatment of **irreducible umbilic hernia** in the adult requires the use of a so-called rim-plate truss. A metal ring, sufficiently large to extend beyond the area of the hernia, covered with chamois, and having its open space filled in by a shallow bag of the same material, replaces the pad used for reducible hernia. It is secured in place by straps and buckles (Fig. 556). An abdominal belt should be worn beneath the truss.

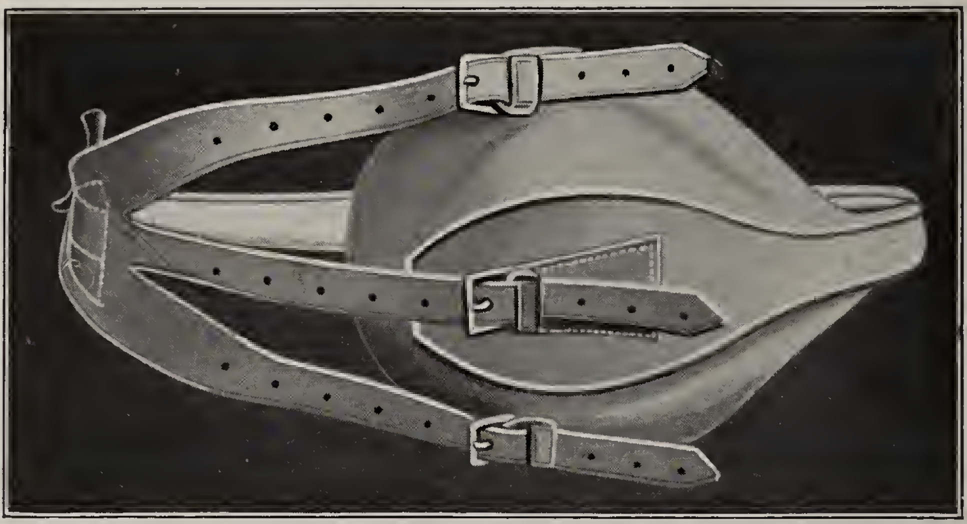

Fig. 556.—Rim-plate Umbilic Truss.

Radical Cure by Operation.—In subjects most favorable for operation, namely, those neither obese nor having irreducible hernias, operative treatment is not demanded, except as a matter of convenience or as a precautionary measure. In view of the great probability that an irreducible condition will finally supervene, it is often desirable. On the other hand, those who most frequently require the radical operation are unfavorable subjects for operation. These are usually corpulent, having both cardiac and renal disease. The occurrence of strangulation in this class of cases is attended by a grave prognosis. Even with simple irreducibility present, the necessity for a prolonged operation in order to clear the protruded mass of the extensive adhesions frequently present, and the difficulties attending the effort to replace the viscera within an abdominal cavity contracted by depositions of fat, combine to render the radical cure by operation in this class of cases one of considerable risk.

In the presence of **ulceration** of the coverings of the hernia the surgeon may conscientiously advise operative interference, and, with the desire on the part of the patient to rid himself of the burden of an irreducible umbilic hernia of unwieldy size, he may consent to undertake the operation, with all its risks. In the face of **strangulation,** the patient's best chance lies in immediate herniotomy.

Whenever time will permit, the patient should be subjected to a rigid and prolonged preliminary preparation with the view of reducing the amount of fat present in the structures within the sac and also that which has been deposited in the cavity of the abdomen in the prolonged absence of a portion of its normal contents. Besides the diet and exercise necessary for this, attention to the cardiac and renal organs is essential. The operation itself is designed to cure the condition by the return of the viscera, the extirpation of the sac, and obliteration of the hernial aperture.

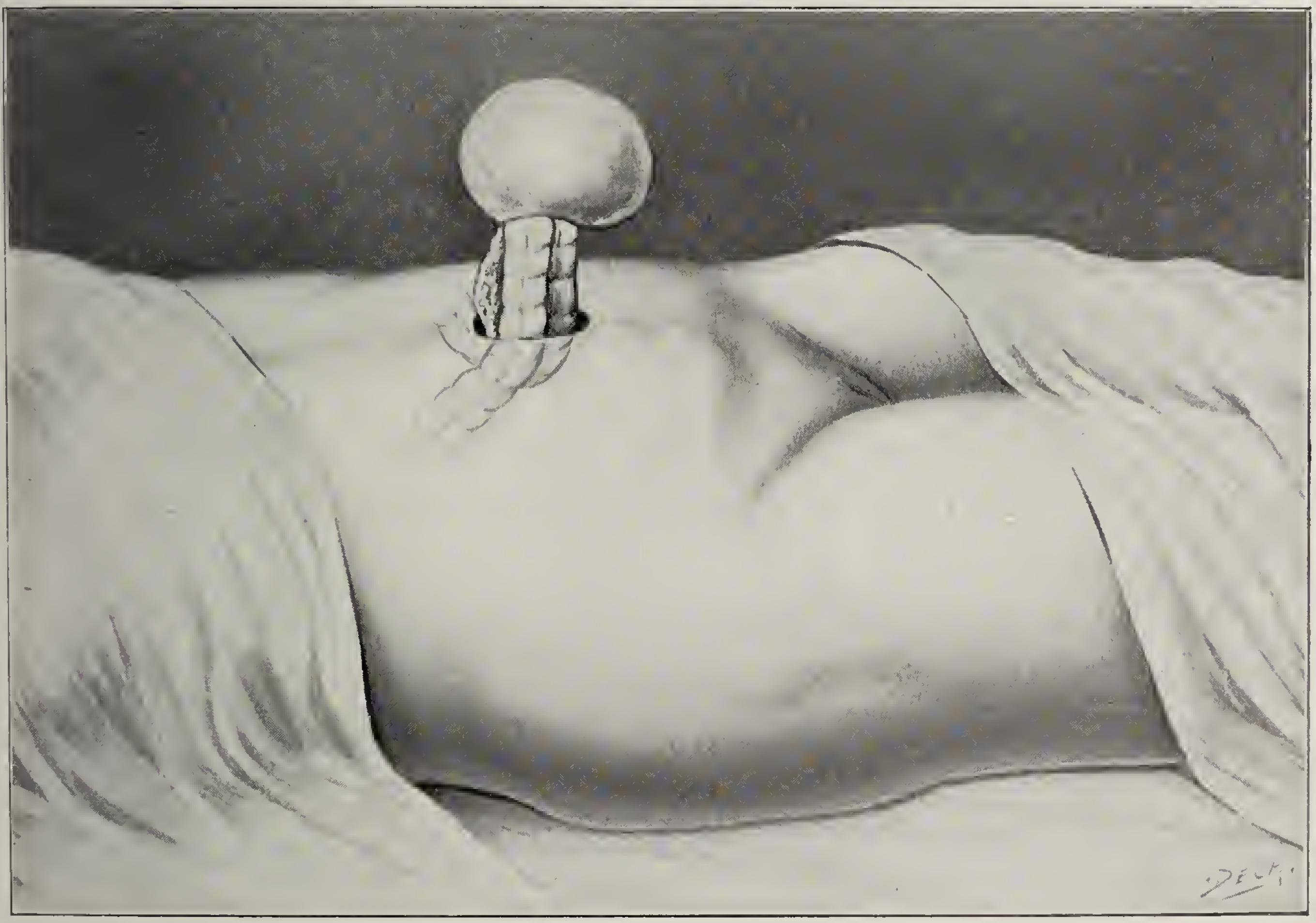

FIG. 557.—THE OPERATION FOR UMBILIC HERNIA.
The vertical elliptic-shaped incision of Delatour has been employed. The thinned hernial coverings and sac have been dissected from the abdominal walls, and the entire mass lifted away from the peritoneal cavity without disturbing the hernial contents.

Two vertically placed elliptic-shaped incisions are made to include the protrusion, the umbilicus, and any points of ulceration that may be present. These are deepened in the fatty and fascial structures outside the hernia on each side of the latter until the muscular wall of the abdomen is reached (Delatour) (Fig. 557). If the shape and size of the hernia require it, the ellipse may be transversely placed (Mayo).

At the point where the incisions meet below the protrusion if these are vertically placed, or at a point just below the umbilic ring if the incisions are transversely placed, the abdomen is opened so as to admit of the introduction of the index-finger of the left hand. With this as a guide the entire thickness of the margins of the ring is incised from without through the incisions already carried down to the musculo-aponeurotic structures. By this means the entire hernial mass is freed and lifted forward and the wound and abdominal cavity at once protected by gauze compresses. The surgeon now strips away the sac and its coverings, ligating and excising omentum when necessary to effect this. Adherent intestine must be carefully dealt with and special precautions taken against infection from portions of ulcerated skin present. As the separation of the hernial contents is completed the latter are returned to the abdomen.

In large hernias the margins of the recti are usually considerably separated. The margins of the wound are divided in such a manner as to separate these into two layers so that the muscular tissue in the entire length of the wound is exposed. These layers are now sutured separately with the crossed or removable layer suture of silkworm-gut. Interrupted sutures of chromicized catgut are applied to the edges of the aponeurosis so as to insure accurate coaptation of its edges.

If the difficulties usually encountered in these cases are considered, the above method of operating is comparatively rapid, and is specially valuable in strangulated cases so frequently the seat of rapid gangrene of intestine, since it permits immediate isolation of the gangrenous and hence septic parts and prevents soiling of the general peritoneal cavity.

When the transversely placed elliptic incisions of Mayo are employed, after excision of the sac and disposal of its contents, the further steps of the operation include (1) separate suture of the peritoneum; (2) the clearing of the aponeurosis of the external oblique a sufficient distance to permit the folding of the upper portion over the lower for an inch or more; (3) the overlapping or overfolding of the aponeurosis in such a manner as to bring in the transverse direction the double line of sutures by which it is secured so that the opening in the musculoaponeurotic structures is completely and effectually closed; (4) suture of the fat layer with interrupted catgut sutures; (5) suture of the skin.

In order to effect the overlapping of the aponeurosis the original opening left by the excision of the sac may be enlarged laterally in both directions. The lower edge of the opening is brought well up beneath that portion of the aponeurosis lying above the opening, where it is secured by mattress sutures of silver wire. The latter are so placed that their twisted ends lie between the surfaces of the aponeurosis. These ends should be left only sufficiently long to prevent untwisting and rolled upon themselves so that the rough cut-off ends do not irritate. The upper edge is now brought down and sutured in position by chromicized catgut.

The patient should be kept in bed for at least a fortnight after the removal of the sutures, or beyond the third week after the operation, and be instructed to wear for an indefinite period a suitable abdominal belt or support. The tendency to relapse is very great in these cases.

Incarceration, or **fecal obstruction** in an umbilic hernia, is of not uncommon occurrence, from the fact that these hernias frequently contain large intestine. This condition should be dealt with on the same general principles as fecal impaction elsewhere, high enemas and gentle taxis or kneading being employed. Should symptoms of strangulation come on, these measures must be abandoned and the case submitted to immediate operation.

Strangulated Umbilic Hernia.—Strangulated umbilic hernia in the adult offers a very grave prognosis. It usually occurs in subjects whose physical condition renders them unfit for an operation of any sort. They are generally corpulent, with large and irreducible hernias of long standing. The strangulation is usually hyperacute, with the gut imprisoned within a loculus, and early gangrene is the rule.

The treatment consists of immediate resort to operation. With the symptoms of strangulation present, it is but little short of homicide to apply taxis, because of the valuable time lost and of the dangers of the procedure itself. The plan of the operation should be on the lines already laid down for the radical cure, which, as previously stated, offers special advantages in strangulated cases.

VENTRAL HERNIA

Protrusions which occur in the anterior abdominal wall in localities other than the inguinal, femoral, and umbilic regions are called ventral hernias. While there may be a congenital predisposition to ventral hernias, yet they are always acquired. They may develop spontaneously, in which case the protrusion takes place most commonly in the linea alba; rarely, however, they occur in the lineae semilunares or the lineae transversae. Or, they may develop as a result of the weakening and stretching of the cicatricial tissue at the site of a wound of the abdominal walls, the so-called traumatic ventral hernias. The first named are found, as a rule, above the umbilicus in males, since the interval between the recti muscles is most marked at this point. In women above thirty and in those who have borne children there is a tendency to separation of the recti below the navel as well. An abdominal hernia may produce a similar separation in the male. Traumatic hernia may occur at any point.

Diastasis of the recti, as well as separation of the muscular structures at any part of the abdominal wall, may be recognized by placing the patient in the recumbent position and directing him to lift the head and shoulders, or the lower extremities with the knees extended. A vertical swelling appears in the median line, and the edges of the separated recti, showing a hiatus in the muscular structures, can be readily made out.

The **treatment** of spontaneous ventral hernia in the linea alba consists in the use of an abdominal support, and, in some instances, of an umbilic truss in addition. If the protrusion is large and gives rise to much inconvenience, or if the wearing of a support is irksome, an operation designed to bring about a radical cure may be performed on the same general lines as for umbilic hernia. If strangulation occurs, this is likely to be very acute and should be treated by prompt operation, without previous recourse to taxis. Only the simplest form of abdominal support is necessary and that only for the first few weeks after an operation for spontaneous ventral hernia.

Hernial swellings in the lineae semilunares and lineae transversae are usually the result of protrusion of fat through the fibrous structures at the site of a congenital or acquired separation of the fibers comprising these. They may give rise to local pain and disturbances of the alimentary tract, in which case they should be treated operatively.

Traumatic ventral hernia may occur after operation, or after any large penetrating wound of the anterior abdominal walls. The injudicious division of muscular tissues in laparotomy incisions, imperfect suture after the latter, the occurrence of suppuration in a properly sutured abdominal incision, the necessity for drainage after abdominal operations, the occurrence of meteorism, too early strain on the scar or the absence of proper support to the suture line, are the common causes. Traumatic ventral hernias are less frequently observed in the young than in middle-aged and old persons.

The **treatment** of traumatic ventral hernia consists in the application of an abdominal support with a properly adjusted pad. While a cure cannot be hoped for by this means, increase in the size of the protrusion may sometimes be prevented. In nonatrophic cases, in which the muscular structures surrounding the aperture are comparatively firm, particularly if the patient is young, the cicatricial tissue should be removed by an elliptic incision, the margins of the aperture split so as thoroughly to expose the muscular layer, and the parts resutured.

When the protrusion is of very large size it may become subject to the complications which occur in umbilic hernia, such as incarceration, strangulation, intestinal obstruction arising from the presence of adhesions within the sac, and ulcerations of the skin coverings thinned from combined pressure from within and without, and may demand operative interference.

OBTURATOR HERNIA

A hernial protrusion sometimes makes its way through the obturator foramen of the innominate bone and thence into the upper part of the thigh. The extraperitoneal connective tissue and pelvic fascia are carried in front of the parietal peritoneum, the protrusion finally passing upward and forward above the upper margin of the obturator muscle, where it lies behind the pectineus. The obturator artery and nerve, when in their usual location, lie on the outer side of the neck of the hernial sac; they are occasionally found in front of the swelling.

This form of hernia is most frequently met with in elderly women, more particularly in those who have borne children, and in those who, having been previously stout, have acquired a general laxity of fiber from rapid loss of flesh. It is rarely recognized before the occurrence of strangulation and may escape detection altogether unless the cause of the intestinal obstruction is revealed by exploratory laparotomy. In the rare cases in which a swelling is found in the upper part of Scarpa's space, or below and to the inner end of Poupart's ligament, the protrusion may be mistaken for a femoral hernia. Pain, referred to the distribution of the obturator nerve, may be present. In examination for an obturator hernia the thigh should be palpated from the inner aspect, when the tumor may sometimes be felt just below and behind the origin of the adductor longus muscle. Exploration of the obturator foramen on its inner surface by means of the finger in the vagina or rectum may assist in the diagnosis.

In the **treatment** of obturator hernia trusses are of no avail, even if the condition has been diagnosed. Moreover, such a large proportion of these cases become the subjects of fatal strangulation that it is well worth while to consider the question of operation designed to bring about a radical cure. In strangulated cases the imprisoned intestine should be released from the abdominal side through a laparotomy incision, made either in the median line or in the corresponding linea semilunaris. In incising the ring the knife should be directed downward and somewhat inward in order to avoid injury to the artery. In withdrawing the contents of the sac care should be taken not to infect the general peritoneal cavity by the contents of a gangrenous and perforated knuckle of intestine.

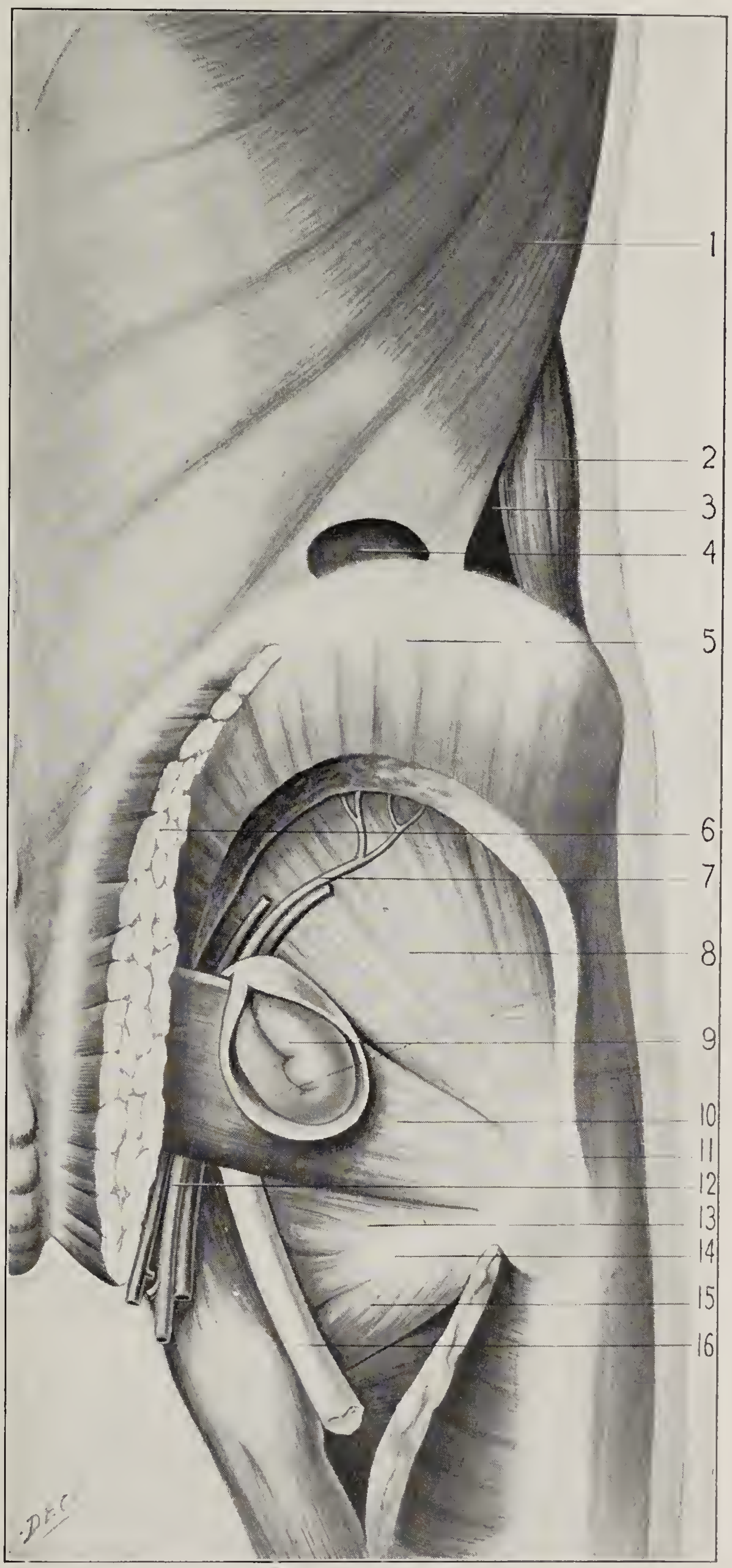

FIG. 558.—PETIT'S TRIANGLE, BRAUN'S SPACE, AND THE ANATOMY OF SCIATIC HERNIA.

1, Latissimus dorsi muscle; 2, external oblique muscle; 3, Petit's triangle; 4, Braun's space; 5, gluteus medius muscle; 6, gluteus maximus muscle; 7, gluteal artery; 8, gluteus minimus muscle; 9, sciatic hernia; 10, pyriformis muscle; 11, great trochanter; 12, sciatic artery; 13, gemellus superior muscle; 14, obturator internus muscle; 15, gemellus inferior muscle; 16, sciatic nerve.

LUMBAR HERNIA

This somewhat rare variety of hernia occurs behind one or the other linea semilunaris and between the last rib and the crest of the ilium. In congenital cases the condition is due to deficiency in the muscular development in this locality, and may be bilateral. Weakening of the muscular structures, the result of operative attacks on the kidney, or a suppurative process arising from hip-joint disease or from osteomyelitis of the pelvic bones, is the usual cause of the acquired variety (**traumatic lumbar hernia**). A true spontaneous lumbar hernia was formerly supposed to occur at the triangle of Petit, a three-cornered space formed by the crest of the ilium, the latissimus dorsi and the external oblique muscles (Fig. 558), and filled by the internal oblique, and the transversalis muscle and fascia. The protrusion is much more likely to occur, however, in the superior lumbar, or Braun's space (Fig. 558), a gap below the last rib, bounded in front by the external oblique muscle, above by the posterior inferior portion of the serratus and the point of the twelfth rib, on the inner side by the sacrolumbalis, and below by the internal oblique. Here the aponeurosis of the transversalis abdominalis is supported only by the latissimus dorsi.*

The **diagnosis** of lumbar hernia must be based on the presence of an elastic swelling presenting the usual characteristics of hernia and occurring in the lumbar region.

The hernial mass is usually easily reducible and rarely becomes strangulated. The condition is to be differentiated from (1) lipomas; (2) fibromas; (3) abscesses. The last named are of special importance, since an incision for supposed abscess would be a serious and probably a fatal error.

The **treatment** consists in the application of a suitable support or belt. Owen operated for radical cure by closing the hernial opening with catgut sutures, and Küster by an osteoplastic flap (skin, muscle, and bone), from the region of the ilium.

SCIATIC HERNIA

This form of hernia may protrude, first, through the great sciatic foramen alongside the superior gluteal artery; second, through the same foramen alongside the inferior gluteal artery; third, through the lesser sciatic foramen. The most important anatomic distinction between this condition and perineal hernia consists in its point of escape from the pelvis above the sacrosciatic ligament. Both varieties finally make their appearance at the lower edge of the gluteus maximus (Fig. 558). As the sciatic hernia increases in size it passes from beneath the lower edge of the gluteus maximus and reaches the upper and posterior part of the thigh. The hernial protrusion is probably due to some congenital deficiency in this region. The hernia is usually small and sometimes no external swelling is present, though it has been observed as large as a child's head. Besides intestine and omentum, the ovary and bladder have been found in the sac. Strangulation occurs in about 35 per cent of the cases.

In the **differential diagnosis** this condition is to be distinguished from such gluteal tumors as cysts, hematomas, abscesses, lipomas, and aneurisms.

Treatment.—In case of strangulation it is best to release the imprisoned viscera from the pelvic side through a median laparotomy incision. An operation for radical cure may be undertaken either from without or from the pelvic side; the former route would probably prove to be the less difficult. Attempts to employ truss pressure usually result in failure.

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* This space is sometimes known as Lesshaft's triangle. Its upper portion is the thinnest part of the lateral lumbar region, the weakness of which is still further increased where the twelfth intercostal nerve, or the subcostal vessels and nerves are transmitted. This is a favorite point for the protrusion of a lumbar hernia, as well as for the formation of an aperture for the passage of a cold abscess from the upper dorsal region. In the tendinous portion of the latissimus dorsi close above the crest of the ilium there are also sometimes found large openings for the passage of the lumbar branch of the iliolumbar artery and vein, which may likewise give opportunity for the passage of cold abscesses and lumbar hernias (Baracz and Burznyski).

PERINEAL HERNIA

The protrusions which make their way toward the perineum through the funnel-shaped muscular layer, consisting of the coccygeus and the pubic and iliac portions of the levator ani and called the pelvic floor or diaphragm, are known as perineal hernias. An opening is left in the pelvic diaphragm for the passage of the urogenital tract, and not infrequently a narrow slit exists, in addition, between the coccygeus and the iliac portion of the levator ani. The protrusion passes through the pelvic diaphragm either through this opening or through the fibers of the levator ani itself. Simple perineal hernia occurs almost exclusively in males; the protrusion passes downward until arrested by the skin. When arrested by the rectum, it is called a **rectal hernia.** This variety occurs in both sexes. When it takes a direction toward the vagina, it is called a **vaginal hernia.** In the variety known as **pudendal hernia,** the protrusion is arrested by the posterior portion of the labia majora.

The most important predisposing cause of perineal hernia is a congenital deepening of the cul-de-sac of Douglas (the rectovesical fold of the peritoneum in the male, and the rectouterine fold in the female, Ebner). By mechanic violence, as, for instance, a fall from a height, the peritoneum is forced into the space between the coccygeus and the levator ani, and a hernial sac is formed; or, an already formed peritoneal pocket, either at the same point or in a congenital slit in the levator ani, becomes suddenly filled with intestine.

A perineal hernia may make its appearance under one of the following forms: (1) The hernia passes down between the bladder and the rectum in the male and appears as a rounded eminence of the skin in the perineum. In women it develops between the uterus and the rectum, and appears either in the neighborhood of the anus or at the posterior portion of the labia majora. When it passes between the anus and the tuberosity of the ischium, it will emerge at the lower edge of the gluteus maximus, as in the case of ischiatic hernia. (2) The hernia may pass in the direction of the rectum or vagina, and force these structures forward and outward, thus giving rise to the hernial prolapse of Rose. Rectal hernias, and in women, posterior vaginal hernias, arise in this manner. (3) The peritoneal protrusion in women may pass into the space between the uterus and the bladder, causing a hernial prolapse of the anterior vaginal wall (anterior vaginal hernia).

The diagnosis of perineal hernia is of great practical importance, particularly when it is to be differentiated from rectal polypus or an abscess. The gravity of an error in this particular need only to be mentioned to be appreciated, since injury to the small intestine from a ligature or écraseur, or an incision, would be quite likely to prove fatal.

Treatment.—External pressure, aided, if necessary, by one or two fingers in the rectum or vagina, is generally sufficient to reduce the contents of the sac. A suitable perineal support, supplemented by a pessary, may be applied. Strangulation should be treated at first by attempts at reduction, since this is usually easily effected. If operative measures become necessary the difficulties of reaching the hernial aperture from without will impel the surgeon to resort to laparotomy. Operations designed to effect a radical cure are carried out with great difficulty, and experience in this respect is wanting.

DIAPHRAGMATIC HERNIA

In this form of hernia the abdominal viscera are protruded into the cavity of the chest. Congenital defects in the muscular apparatus of the diaphragm constitute the predisposing cause and pressure on the abdomen the most common exciting cause of this condition. Protrusions occurring after birth through pre-existing congenital defects, as well as traumatic cases due to stab and gunshot wounds and crush injuries, are included in a separate group and are known as the acquired form. A sac may or may not be present in the cases occurring at birth or in those acquired cases of congenital origin; in the traumatic form a sac is usually wanting. If a peritoneal covering of the hernia is present, the hernia is called a true hernia; if absent, it is called a false one. The presence or absence of a sac will depend on whether the diaphragm is completely perforated or not.

Diagnosis.—In spite of the not unimportant number of cases recorded (483; Thoma, Grosser), the diagnosis in the living has not been made more than half a dozen times. Digestive disturbances play an important part in the symptomatology, on account of the frequency with which the stomach is displaced into the thoracic cavity in diaphragmatic hernia. The tympanitic note and absence of breath sounds on the corresponding side of the chest simulate the signs of pneumothorax. The former is increased by distention of the stomach or inflation *per rectum.* The greater frequency of occurrence on the left side renders displacement of the heart to the right a noteworthy symptom. The occurrence of intestinal obstruction in acquired traumatic cases, of extreme dyspnea in cases of large protrusions, and finally of fatal cyanosis are characteristic signs.

Hirsch, in a case of diaphragmatic hernia in which the diagnosis was already made, confirmed the latter in an interesting manner by means of the Röntgen rays.

Treatment.—This is usually too late to be of service. In strangulated cases immediate laparotomy and replacement of the intestines by traction are indicated. It has been proposed to enter the chest through a horseshoe-shaped incision, then to turn back a flap and resect the ribs to a sufficient extent to gain access to the viscera which are to be replaced, and subsequently to close the hernial opening by suturing (Perman). In congenital cases, with a large passage of viscera into the thorax, replacement is impossible on account of the contraction of the abdominal cavity and the consequent want of room to return them.

INTERNAL HERNIAS

These include those protrusions of the abdominal viscera into physiologically preformed peritoneal pouches or sacs within the cavity of the abdomen. The term does not include the passage of viscera into peritoneal pouches or beneath bands having their origin in pathologic processes, such as adhesions, etc.

Internal hernia may occur (1) through the foramen of Winslow; (2) into the duodenojejunal fossa; (3) into the retrocecal fossa; (4) into the intersigmoid fossa; (5) beneath an abnormally developed lateral vesico-umbilic fold.

Hernia through the Foramen of Winslow.—The omental bursa may be considered as the previously formed sac of an internal hernia, though, on account of the narrowness of the epiploic foramen, or the foramen of Winslow, and the relations of the opening to the liver and the transverse colon and its mesentery, a hernia in this situation is rare. According to Maydl, it has been observed eight times; one-half of the cases were strangulated. Either an abnormal length of mesentery or an excessive dragging on the normal attachments of the large intestine must exist, in order to permit the entrance of a portion of intestine into the omental bursa.

Hernia into the Duodenojejunal Fossa.—The duodenojejunal fossa of Brösike (Fig. 559) is one of a series of peritoneal pockets more or less constantly found at the point of junction of the duodenum with the jejunum. This fossa is distinguished from the others by the fact that the inferior mesenteric vein and sometimes the arteria colica sinistra passes along its upper border. In Aschoff's case the opening was found between these vessels. The occurrence of a hernia in this locality depends on the presence of a congenitally deep fissure in the peritoneal investment, which, in later life, is converted into a recess or fossa by the entrance of the neighboring viscera. In rare cases the hernia forms to the right of the median line. Nearly the entire small intestine may enter the fossa (Fig. 560).

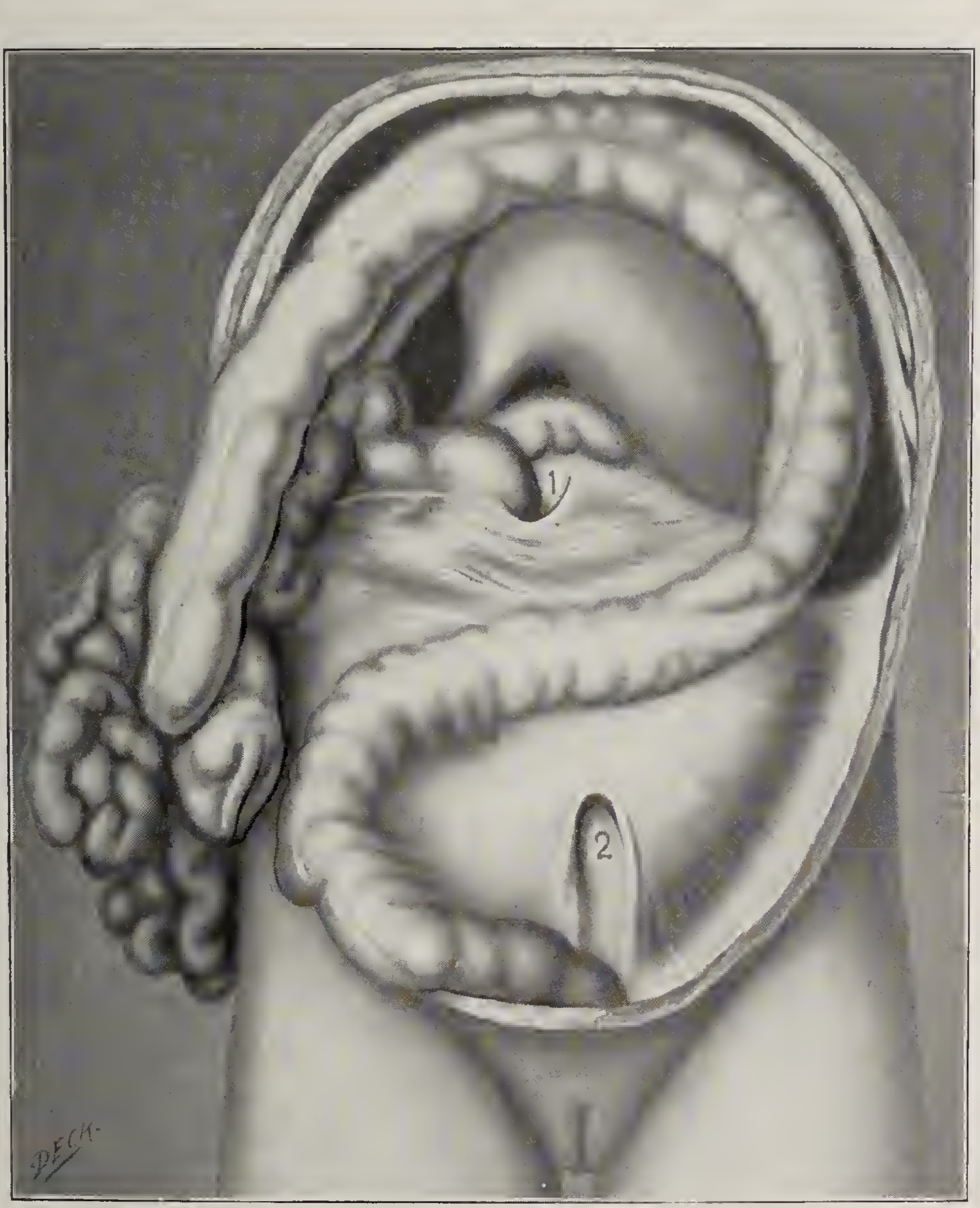

FIG. 559.—1, DUODENOJEJUNAL FOSSA; 2, INTERSIGMOID FOSSA.

Hernia into the Retrocecal and Ileoappendicular Fossae.—There are three distinct peritoneal depressions in the neighborhood of the cecum. The first is formed behind the cecum, where the parietal peritoneum is reflected on the anterior surface of the cecum, in the fold known as the plica cecalis. It is sometimes extended into a recess or fossa, called the retrocecal fossa. The second is but a slight depression, lying to the median side of the cecum, and is of no practical importance, since a hernia at this point has never been observed. It is called the superior cecal fossa. The third depression is formed by the plica iliocecalis as it passes in a bridgelike manner from the mesoappendix to the anterior aspect of the ileum, and is called the inferior cecal or ileoappendicular fossa (Fig. 561). Hernia into the retrocecal fossa, as well as into the ileoappendicular fossa, is exceedingly rare.

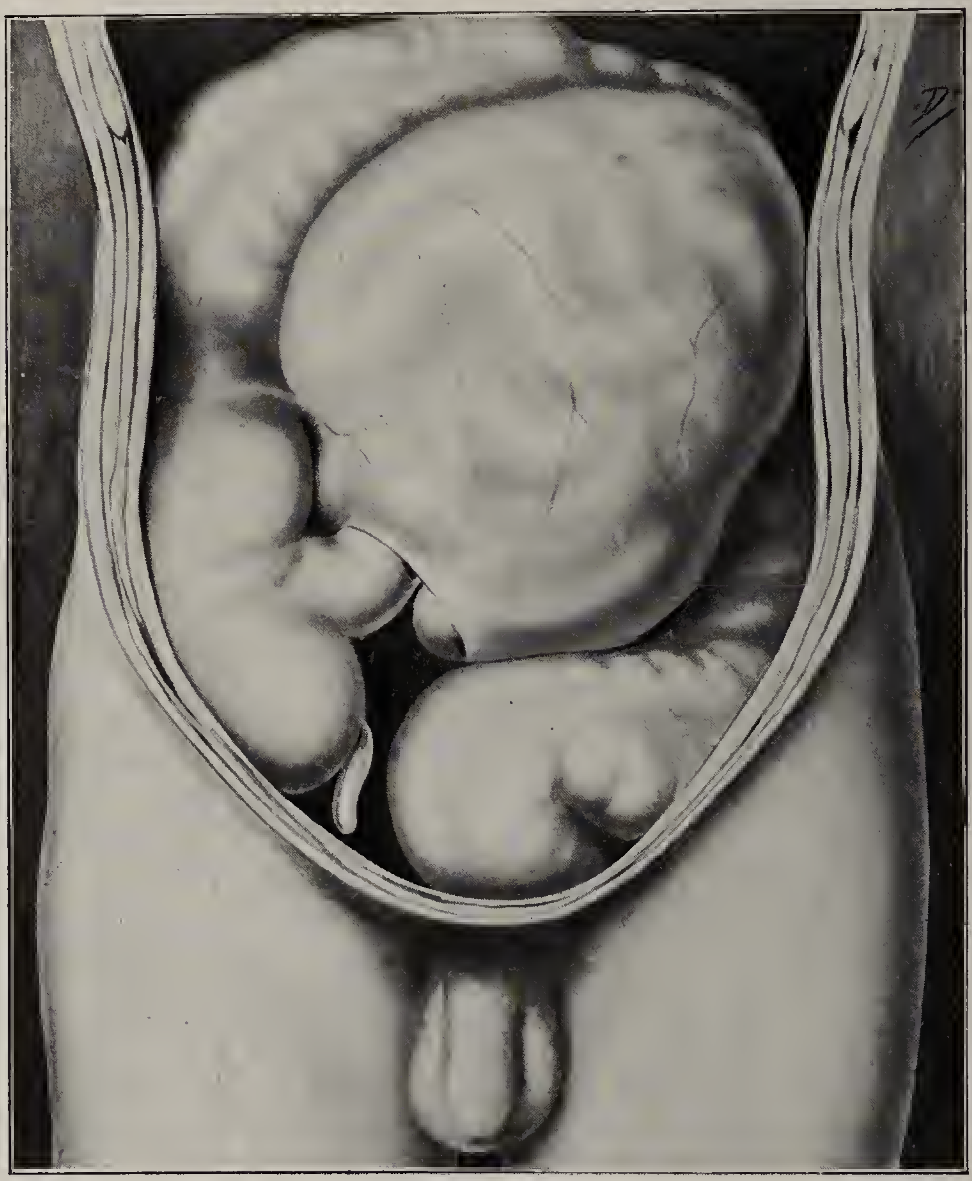

Fig. 560.—Hernia Duodenojejunalis (Sultan, after Aschoff). Non-strangulated Cases.

Hernia into the Intersigmoid Fossa.—A small peritoneal pouch is sometimes found lying behind the peritoneum, with its opening at the root of the mesentery of the sigmoid flexure of the colon, and is called the intersigmoid fossa (Fig. 559, 2). According to Jonnescu, a hernia in this situation has been observed only twice.

Retrovesical Hernia.—In rare cases the lateral vesico-umbilic fold (Fig. 525) is so strongly developed that a peritoneal pouch is formed, which may lead to the formation of a hernia at this point (Linhart, Aschoff, Kaufmann). Should the pouch be directed toward the floor of the pelvis, it may find its way through the levator ani and give rise to a perineal hernia.

The **symptoms of internal hernia** are in no manner characteristic, and even when incarceration or strangulation has taken place, these differ in no way from the clinical picture of intestinal obstruction.

The **treatment** consists in promptly opening the abdomen as soon as intestinal obstruction from this cause or from any other cause is diagnosed. The obliteration of the sac, particularly in the case of the hernias in the cecal region, as well as in the intersigmoid variety, is best effected by packing with sterile gauze (Sultan), since closure of the hernial opening by suturing may lead to the formation of a peritoneal cyst at this point, with fatal obstruction from pressure upon the intestine (Reise, Schott). In the other varieties of internal hernia complete closure of the hernial opening by suturing may be attempted.

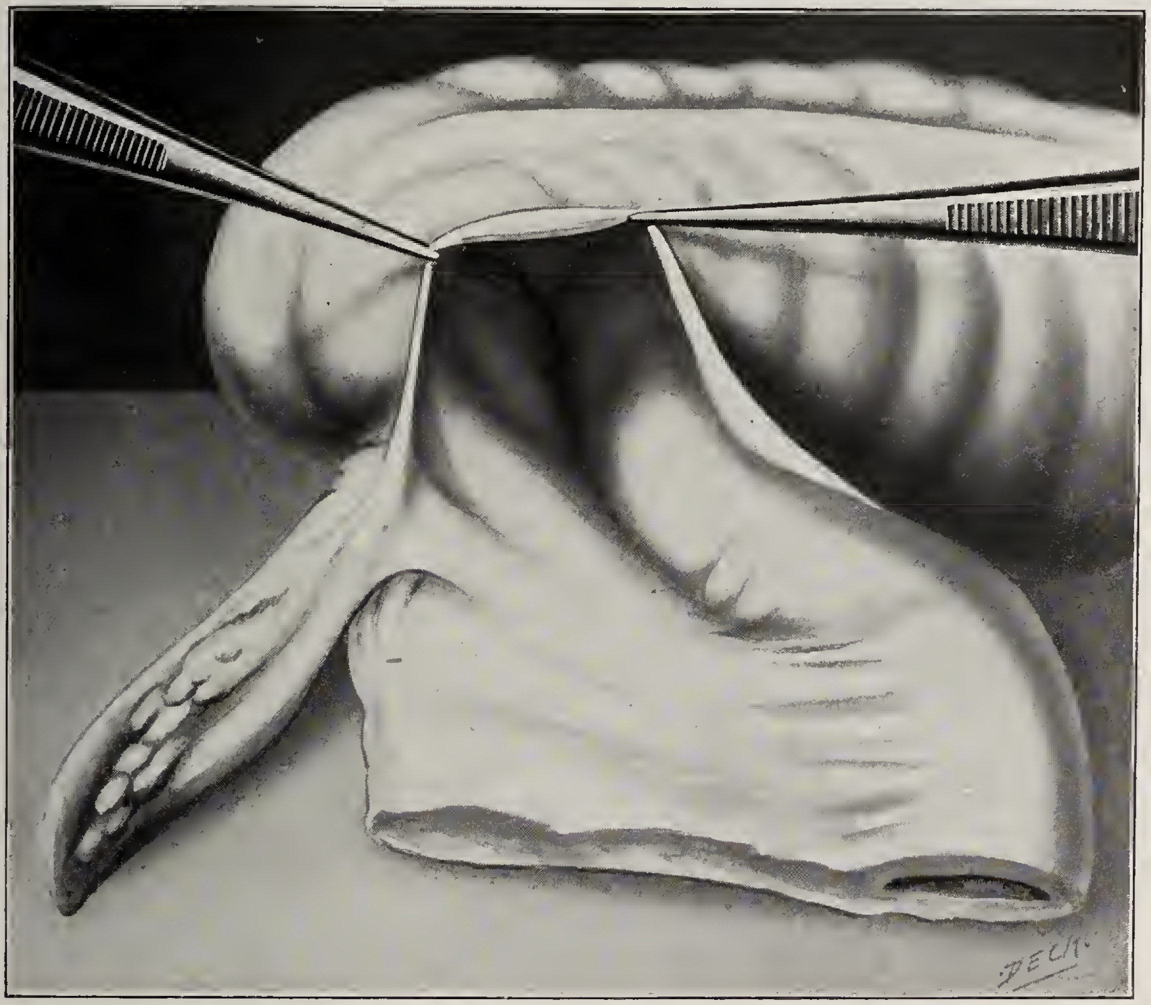

Fig. 561.—Ileo-appendicular Fossa (from Sultan).

THE KIDNEYS

Subparietal Injuries.—These may vary from a slight contusion to extensive rupture of the organ. The cortex is almost invariably involved in even slight ruptures. The most common causes of subparietal injuries are blows, kicks, crushing between moving bodies, the compression of the trunk between resisting bodies, falls from a height, and the forcible doubling up or bending of the trunk (Morris). The rupture is ordinarily stellate and transverse, and extends into the pelvis. In the majority of cases hemorrhage takes place in the circumrenal connective tissue. With complete rupture the hemorrhage is considerable and death may rapidly ensue, particularly if the peritoneal covering is also torn. In other cases the blood is poured out behind the peritoneum. Slight lacerations of the pelvis or ureter may lead to occlusion and consequent hydronephrosis. More extensive injuries to these parts may lead to retroperitoneal extravasations of blood and urine, and subsequent abscess. Both organs may be injured at the same time.

The **symptoms** are as follows: (1) Shock and collapse, if the injury is great and hemorrhage considerable. (2) Hematuria. This may be absent in extensive injuries and present when but slight injury has taken place. In some cases blood-clots, molded in the shape of the ureter, are passed during the first two days. Microscopic casts of the uriniferous tubules may be found. The hematuria usually ceases in from two to five days, but it may continue for several days or a week or more, and yet recovery ensue. (3) Pain in the renal region or in the abdomen in front, radiating to the testicle, groin, or thigh. If the peritoneal covering is torn and blood escapes into the peritoneal cavity, pain in the abdomen will be a marked feature. If the ureter is plugged, there may be renal colic. (4) Frequent and painful micturition. (5) Diminution of urine if one kidney is extensively injured, or if the ureter is plugged with a clot, and total suppression if both organs are severely injured or the renal vessels plugged. In aseptic cases the temperature rises slightly, 100° to 102°, and falls in a few days.

Death may ensue even after a day or two, from persistent hemorrhage. Peritonitis may take place from a rupture of the peritoneal covering communicating with the pelvis of the kidney and extravasation of blood and urine; or later on, by infection from the retroperitoneal connective tissue. Perinephritic suppuration may occur. Retention of urine in the kidney from plugging of the ureter by a blood-clot may lead to hydronephrosis, pyonephrosis, pyelonephritis, or renal abscess. Recovery may follow even quite extensive rupture. The liver and spleen are frequently injured at the same time and fractures of the vertebrae and ribs may occur. Retention of urine in the bladder may result from plugging of the urethrovesical orifice by a blood-clot.

The **prognosis** in rupture of the kidney is always grave. The mortality varies from 22 per cent in uncomplicated cases, when the rupture is limited to one kidney, to 87 per cent in cases complicated by fractures or injuries to other organs including the other kidney (Rovsing).

The **treatment** consists of absolute rest in bed for at least three weeks to avoid secondary hemorrhage. Compression should be applied to the abdomen by means of masses of cotton held in place by a binder. An ice-bag should be applied to the renal region of the injured side. The patient is to be kept on a light fluid diet. The internal administration of ergot is recommended (Morris). Suprarenal extract has been suggested. When the indications are clear, nephrectomy may be performed to arrest the hemorrhage. In cases where there is an inability to relieve the bladder of its accumulated blood-clot and urine by voluntary effort or the catheter, a lithotrity evacuator may be tried to break up and remove the clots. Or suprapubic aspiration of the urine may be employed, time for disintegration of the clots being given in this way. Finally, as a last resort, suprapubic or perineal cystotomy may be performed. Perirenal suppuration will require lumbar incision. Secondary nephrectomy may be required later on.

Open Wounds of the Kidney.—These may be caused by a bullet or other missile, by a sword or bayonet, or other sharp or blunt instrument, or by the horn of an animal. They may be complicated by wounds of the peritoneum or of the other viscera. The injured kidney may protrude through the wound. Extravasation and inflammation occur only when the pelvis has been opened (Fenger).

The **symptoms** are hemorrhage, pain, and shock. The blood may escape externally and extravasation take place at the same time. Hematuria may occur (58 per cent of cases, Fenger). The size and location of the wound may permit ocular inspection and digital exploration. Pain may be referred to the wound alone or may radiate down the groin to the thigh or to the testicle. Pains simulating those of renal colic may occur from the blocking of the ureter by blood-clot. Urine may escape externally when the wound communicates with the pelvis of the kidney. Nausea and vomiting frequently occur. Foreign substances (bits of cloth, etc.) may be carried in by the missile or instrument and escape by the urethra. The **sequels** are suppuration of the wound, perinephritic abscess, pyelitis, and peritonitis.

The **treatment** consists in the cleansing of the parts, enlargement of the wound, removal of foreign bodies, and tamponing by sterile (not iodoform) gauze if the hemorrhage is parenchymatous; if the bleeding is dangerous, nephrectomy should be employed. Tying the pedicle in sections is preferable to ligation *en masse*. A prolapsed kidney, if it is severely lacerated or if its main vessels are injured, should be removed if another kidney is present; otherwise it may be replaced. Inflammatory and suppurative sequels should receive appropriate treatment (lumbar incision, nephrotomy, nephrectomy).

Nephrolithiasis.—This may occur in the shape of calculi of considerable size lodged in the kidney (kidney stone), or those so small as to be scarcely recognized by the naked eye (gravel). These may be of constitutional or of purely local origin. Nephrolithiasis is most common before the age of fifteen and after the age of fifty. Climatic and dietary conditions seem to be involved in its causation.

The larger stones may be rounded, with smooth surfaces, or branched from a central body, like a piece of coral. The branches correspond to the calices within which they form. A branch may form in the pelvis and ureter. The smaller concretions are found in the pelvis, infundibula or calices, as well as in dilated tubules and abnormal cavities in the kidney structure.

Renal calculi may be divided into primary and secondary deposits. **Primary calculi** are precipitated from the urine in the kidney without the necessary occurrence of any change in that organ, and independently of any septic condition of the urinary passages. This species includes calculi consisting of (1) uric acid; (2) urates of soda and ammonia; (3) oxalate of lime; (4) phosphate of lime; (5) carbonate of lime; (6) cystin or cystic acid; (7) xanthin or uric oxid (Morris). **Secondary calculi** occur in kidneys previously diseased and are the secondary effects of septic processes within the pelvis and calices. They are made up of phosphate of ammonia and magnesia, or of a mixture of the ammoniomagnesium phosphate and phosphate of lime. Primary calculi may be largely increased by deposits of these cells after their presence has set up septic conditions of the kidney.

A small blood-clot, a bit of fibrin, or tumor tissue may serve as a nucleus for a calculus. Calculi of uric acid are smooth, while those of oxalate of lime have a rough exterior; phosphatic calculi are gray and comparatively soft.

Inflammatory changes, which may or may not terminate in suppurative conditions, occur as the result of irritation excited by the presence of a stone in the kidney. Gross lesions of the organ, as well as changes incident to interstitial nephritis, are the rule. Separate cavities containing urine (dilatation of tubules from retention) are commonly found. Where many of these cysts are present, the organ is increased in size, while the cortex is almost obliterated; or atrophy may occur from destruction of the glandular structure. In some cases cancer seems dependent on the continued irritation of a retained calculus.

The **symptoms** of stone in the kidney vary with the size and character of the stone. The passage of a medium sized oxalate of lime (mulberry) calculus along the ureter will give rise to a paroxysm of renal colic. In case the stone does not pass, habitual nephralgia, with occasional paroxysms of acute symptoms, is observed. The nephralgia sometimes radiates along the ureter and into the thigh and testicle, occasionally persisting in these regions after it has subsided in the loin. The pain is usually increased by exertion or pressure. Tenderness may sometimes be excited by deep pressure. Deep percussion over the kidney may cause pain in the loin even when pain on pressure is absent. The severity of the pain is not a criterion of the size or other physical characteristics of the stone. Occasionally the habitual pain is absent, and only acute paroxysms, which terminate suddenly, are experienced. This sudden cessation of pain may or may not coincide with the escape of the calculus from the ureter into the bladder. It may denote simply an arrest of the contractions of the walls of the cavity in which the calculus lies. Such contractions and pain may occur without the presence of a stone or a similar exciting cause. Finally, attacks of renal colic may be due to angulation of the ureter with or without movable kidney (intermitting hydronephrosis), no stone being present.

Other symptoms are **nausea** and **vomiting** during the paroxysms, which are most marked during the day, **frequency of micturition, diminution,** and in some cases **total suppression of urine,** and the intermittent occurrence of a small amount of **blood in the urine.** Other changes in the urine consist of heightened color, scantiness, and a persistent hyperacidity. Uric acid crystals deposit on standing, as shown by the dark brown stain of the vessel; crystals of oxalate of lime are found on microscopic examination. The latter may also reveal red blood-corpuscles and epithelium from the pelvis or ureter. The disease occurs much more frequently in men than in women and in those who are high livers and lead a sedentary life. Mucus and pus are not usually found unless pyelitis has supervened. When the latter occurs, phosphatic incrustation may take place.

The **diagnosis** of stone in the kidney is based on the unilateral and radiating lumbar pain, tenderness in the renal region, blood in the urine, particularly on exercise, the condition of the urine, and the history, in some cases, of previous attacks of renal colic. When the acute paroxysms occur on the right side, the disease is to be differentiated from appendicitis, hepatic colic, intermittent hydronephrosis caused by angulation of the ureter, uterine colic, and ovarian neuralgia. Tuberculous pyelitis and pyonephrosis are also to be excluded. An *x*-ray examination may assist in clearing up the diagnosis in an obscure case.

The **treatment** consists in preventive measures. The diet should be abstemious. The use of nitrogenous food should be reduced and an alkali should be employed occasionally, such as the liquor potassii citratis. Water should be drunk freely. Piperazin is useful. Exercise should be taken between the attacks. In the case of phosphatic calculi strychnin and mineral acids should be prescribed and the parts kept at rest as much as possible. In oxalate of lime calculi the patient's diet should be restricted and phosphate of soda in half dram doses three times a day ordered. He should drink copiously of lithia water and pure spring-water. Acute paroxysms must be met by a full dose of morphin administered hypodermically, and ether or chloroform when demanded by urgency of the symptoms. A full hot bath is sometimes of service.

The indications for **surgical interference** are present when the symptoms persist and it is reasonably certain that the stone has lodged. Operative measures consist of **exploratory incision, nephrolithotomy, nephrotomy** for purposes of drainage of purulent or cystic collections, and **nephrectomy.** The first named consists of exposing the kidney and exploring its interior with an exploring needle, but the surgeon must be careful to avoid injury to the large vessels at the hilum. With the discovery of the calculus the organ is incised for the purpose of removing the stone. The patient's condition may not admit of removal of the kidney, or sufficient of the organ may still remain intact to justify an attempt to save it. If the urea is below 1 per cent, nephrectomy should not be performed (Keen). Persistent urinary lumbar fistula may indicate a secondary operation for the removal of the organ. (For Nephrectomy, see page 224.)

Pyelitis and Pyelonephritis.—This is a subacute or chronic catarrhal, or a suppurative inflammation of the pelvis of the kidney. When associated with nephritis, it is called **pyelonephritis.** A **pyonephrosis** is the distention of the pelvis, together with more or less of the thinned structure of the kidney itself, with purulent contents. **Ascending pyelitis** may occur as a part of a sequence of events commencing at the lower urinary tract (urethritis, cystitis), or the disease may be local to the pelvis itself, as in renal calculus and tuberculous disease of the organ. In addition to these causes are to be mentioned traumatism, certain general diseases depending on infection (osteomyelitis, typhoid fever, diphtheria, septicemia, pyemia), foreign bodies (fragments of bone from a lumbar vertebra, parasites, blood-clots), the effects of irritating drugs (cantharides, turpentin, cubebs), obstruction of the ureter by a calculus, pressure of the gravid uterus or of a tumor, and more remotely chronic obstructive disease of the lower urinary tract. The infliction of a slight traumatism on the urethra or the bladder may be the immediate determining cause of a pyelitis in these cases. As predisposing causes may be mentioned decreased power of resistance dependent on paralysis following injury or disease of the cord. Gonorrheal infection from the latter is said to occur (Keyes). The bacteria most commonly found are Staphylococcus aureus, the colon bacillus, Streptococcus pyogenes, the pneumococcus, and Eberth's bacillus.

Pyelitis is essentially a chronic disease. In its acute form it is not common, but is usually a complication of acute disease of the kidney proper, except when caused by the ingestion of irritating drugs.

The **symptoms** of the chronic form of pyelitis of local origin are usually the symptoms of the condition on which the disease depends, plus certain changes in the urine, and finally the symptoms of chronic sepsis (the so-called **urinary cachexia**). The urine remains acid, but at the same time becomes turbid from admixture of pus. The latter is deposited as a thick, greenish, and oily looking layer, the supernatant urine remaining clear. The urine maintains its acidity for several days. The quantity of albumin is large and is often accompanied by an abundance of globulin. There may or may not be blood in the urine. Examination may show the organ to be enlarged, and tenderness may be elicited on deep pressure, but spontaneous pain is rare. Perinephritic abscess may be present. With the supervention of suppuration, fever of the hectic type, with slight or severe chills, and general deterioration of the health, occur. In the ascending form the early symptoms of pyelitis and pyelonephritis may be masked by those of the cystitis.

The **diagnosis** is to be made on the above symptoms, the presence of epithelial cells from the kidney, and of molded masses made up of conglomerations of pus cells resembling tube casts. Acidity of the urine, with deposit of purulent matter, is evidence against cystitis. In pyelitis the urine drawn by the catheter a quarter of an hour after irrigation of the bladder will be purulent. The use of the cystoscope will also serve to exclude cystitis, and the collection of the urine from the separate kidneys by catheterization of the ureters will determine which organ is affected. The tuberculous variety may be suspected if other organs give evidence of tuberculosis, or it may be present without this. Examination of the urine may show the presence of the tubercle bacillus.

The **treatment** of acute cases consists of rest in bed, the use of diluent drinks and hot fomentations, administration of an alkali to diminish acidity of the urine and opium to relieve pain. Urotropin is to be given in 7½-grain doses every four hours, to render the urine aseptic. Tannic acid, when there is much mucus (Morris), and quinin in tonic doses are useful drugs. The **surgical measures** indicated, in addition to those designed for the relief of obstructive disease of the urethra and urethrovesical orifice, are those already mentioned in connection with nephrolithiasis, viz., nephrolithotomy, nephrotomy for drainage, and nephrectomy. The first will follow the second naturally if calculus is found. The third may be performed as a primary operation if conditions demanding it are present, as, for instance, in cases where no active kidney tissue remains or where the kidney is the seat of multiple abscesses, or it may be performed, and generally with greater safety, as a secondary operation if the condition is not relieved, or if a fistula remains.

Tuberculosis of the Kidney.—In primary renal tuberculosis groups of miliary tubercles form beneath the mucous membrane of the pelvis, or in certain portions of the cortex. In these cases the infection without doubt takes place from the blood-stream. The bladder and prostate are secondarily involved and from them the other kidney. In cases secondary to tuberculosis of the bladder both kidneys are affected. In cases in which the disease is unilateral the right kidney is more frequently attacked than the left.

The **symptoms** strongly resemble, in their entirety, those of renal calculus. The onset of the disease is marked by polyuria, vague lumbar pain, and cloudy urine from admixture of mucus and pus. These symptoms may be ushered in by a chill followed by severe pain; acute renal colic is rare. The urine has a low specific gravity, is acid, and light colored. On standing, it deposits a thin layer of pus, with streaks of blood and debris of connective tissue. Small masses of caseous material may be present. Albumin appears early. Koch's bacillus, though undoubtedly present, may not always be found. Inoculation tests of the urine deposit may be successfully practised on animals (Rovsing).

Diagnosis.—The symptoms simulate those of renal calculus coming on without renal colic. The absence of oxalate of lime and uric acid crystals from the urine, and the early appearance of pus forming a layer in the bottom of the glass, with a clear and light colored supernatant acid fluid, are diagnostic. The localization of pain and tenderness on one side, suggests the unilateral character of the case. The question of involvement of one or both organs may be determined by ureteral catheterization, aided by the cystoscope. Milking the pelvis and ureter, *i. e.*, external massage and stroking manipulations made after the bladder has been emptied and washed out, followed by the collection and examination of the bladder contents obtained by a second washing (Israel), will assist in determining the source of the purulent material. The presence of tubercle bacilli will prove the diagnosis. Their absence, on the other hand, is of no importance.

Treatment.—The early appearance of bladder symptoms may lead to unnecessary, and perhaps harmful, instrumentation. Cystitis from this cause should be studiously avoided. Operative interference consists of the following: (1) Exploratory lumbar incision and the removal of a calculus if this is present. (2) Splitting the capsule and simply draining, or excising any tuberculous focus found. This is the operation of choice when both kidneys are involved. (3) The immediate performance of nephrectomy, if the disease is limited to one side and the organ is indubitably affected, provided another kidney is present and the patient is free from advanced tuberculosis elsewhere in the body. Nephrotomy can no longer be considered a curative operation in tuberculosis of the kidney. Pain should be controlled by codein and the general health improved by the measures employed in tuberculous diseases elsewhere.

Perinephritic Abscess (Abscess of the Lumbar Fossa).—This is a suppurative inflammation of the perirenal connective and adipose tissues. As a primary affection it is usually due to some traumatism, such as contusion. When of secondary occurrence it is the result of (1) an extension of infection from the kidney or some other organ such, for instance, as the appendix vermiformis; (2) some general cause, such as pyemia or septicemia.

The suppurative process may invade the liver, spleen, suprarenal capsule, or stomach. The pus may perforate the colon, or, more rarely, the peritoneal cavity. It may perforate the diaphragm and adjacent lung and finally empty into a bronchus. Under these circumstances it may give rise to a rapidly fatal issue.

The **symptoms** vary with the cause. In primary cases these may come on suddenly or appear gradually. In the secondary forms the onset is usually slow and the formation of the abscess is obscured by the primary affection. The pain is usually referred at first to the affected region, and as a rule is dull and continuous, though it may be severe and remitting. Later on it may radiate to the lower part of the abdomen, external genitals, and thigh. It is increased by pressure and movements. An increase in the pain by movements of the corresponding hip, or persistent flexion of the thigh from irritation of the psoas, may cause it to be mistaken for morbus coxarius (Gibney). Palpation reveals tenderness and the presence of a tumor. In abscess secondary to infection from the kidney the symptoms of the renal affection will also be present.

After evacuation the abscess may pursue the course of an ordinary phlegmon, in primary cases. In secondary cases the suppurative process does not cease until the cause has been removed. The **prognosis** is graver in secondary than in primary cases.

The **treatment** in the early stages consists of measures to relieve pain and diminish fever. The latter effect is best accomplished by evacuation of the abscess as soon as the true nature of the case is established, and antiseptic irrigation and drainage. The abscess cavity should be thoroughly explored, with the view of removing the cause, if the suppurative process is secondary to some other local affection. The cavity should be treated by tamponing with iodoform or zinc oxid gauze until its deeper parts have become completely obliterated.

Fistulas in the Renal Region.—These may or may not communicate with the interior of the kidney. In the latter case urine escapes therefrom; this is known as a **urinary fistula.** An opening leading down to a blind extremity near the kidney, but not communicating therewith, is known as a **perinephritic sinus.** Fistulas in this region are usually the result of suppurative processes, which originate either within or about the kidney. They are generally maintained by the conditions which caused the original suppuration, such as the presence of a calculus, a tuberculous focus, or a foreign body. Irregular and rigid conditions of the walls of the abscess cavity may be sufficient to cause their persistence. Obstruction in the ureter also causes them. Those resulting from wounds of the kidney are not usually persistent.

Renal fistulas may open into the intestinal canal (**intestinorenal**) or into the stomach (Morris, Chadwick). In the former the communication is usually with the colon, and pus, possibly mingled with urine, escapes *per rectum.* Less frequently the communication is with the duodenum. In **gastrorenal** fistula there is gastric pain and vomiting, with the appearance of undigested food in the urine.

The **treatment** consists in the removal of a foreign body or calculus, if either of these is present. In cases where this treatment fails, and in tuberculous cases, nephrectomy is indicated, provided the existence of the other kidney can be demonstrated.

Malpositions and Malformations of the Kidneys.—**Horseshoe kidney** is the most frequent of the congenital abnormalities of the organ. The kidneys are united at the lower ends by a transversely placed and curved band of renal tissue. The double organ thus formed is most frequently displaced in a downward direction and is usually situated almost directly in front of the spinal column. The united kidneys may, however, be placed on one side of the spine or in the pelvis.

Simple Misplacements.—One or both organs may be placed either higher or lower than normal. When but one kidney is misplaced, it is usually the left, and it is situated at or near the promontory of the sacrum. **Anteversion of the kidney** may be present (Potain). Finally, one or both kidneys may be rotated on one of the axes and there firmly fixed.

Absence of the kidney, oftener of the left kidney, is not uncommon. This may be complete, or there may be found on operation a mass of connective tissue in the situation proper to the kidney, with or without a rudimentary ureter. In these cases the existing kidney is much enlarged and may be displaced downward.

Displacements occur as a congenital deformity and in adult life as a result of tight lacing, pathologic enlargements of the liver and spleen, and absorption of the perirenal fat or as the result of traction through the medium of adhesions to tumors or neighboring organs, particularly the large intestine.

Congenital Floating Kidney.—This is of rare occurrence. It depends on a disposition of the peritoneum, which causes the latter completely to surround the organ and its vessels, so that a mesonephron is formed (Morris).

Movable Kidney.—The view that the kidneys are fixed organs is incorrect. They possess a normal range of movement of upward of an inch (Albarran). A kidney may be said to possess abnormal mobility when, with the patient in the upright position, it fails to reascend with tranquil expiration after being drawn down by forced inspiration (Moullin). This condition is found more frequently in women than in men. Lancereaux gives the proportion of 55 women to 5 men. The right kidney is from twelve to thirteen times more often affected than the left (Morris). Enteroptosis may coexist (Glénard). Both kidneys may be involved. The more frequent occurrence of movable kidney in females is due to the shallowness and more cylindric shape of their lumbar recesses, these spaces in males being deep, narrow, and pear-shaped, with the narrow end below. The preponderance of right-sided cases is due to a slight torsion of the lumbar spine normally present in right-handed persons. The left transverse processes rotate backward and deepen the lumbar recess on that side at the expense of the right, which is made more shallow by the forward rotation of the right transverse processes (Moullin).

An increased mobility of the kidney in its position between the peritoneum and the posterior abdominal muscles is present. This may vary from a barely perceptible movement to an encroachment by the organ on the abdominal cavity as a freely movable tumor, or its displacement downward into the pelvis. The patient suffers from a dragging sensation in the loin; attacks of pain arising from rotation on the pedicle occur, which resemble renal colic, with reflex vomiting, constipation, flatulence, and other symptoms of gastro-intestinal disturbance. Partial twists of the pedicle or angulation of the ureter from extreme displacement may give rise to diminution of the secretion of urine and high specific gravity of the latter; compression of the vessels may produce changes in the renal structure. The patients are frequently nervous and hysteric and may be hypochondriac. Women are likely to suffer from coincidental disorders of the genital organs. The symptoms are liable to be increased at the menstrual periods. The symptoms of movable kidney are due to the mobility rather than to the malposition of the organ (E. Hahn) and are relieved by rest in the recumbent position. Among the unusual results of movable kidney that have been observed may be mentioned (1) torsion and consequent acute congestion and acute hydronephrosis, and hematuria; (2) tuberculosis of the kidney; (3) hydronephrosis followed by pyelitis.

The **diagnosis** rests on the above symptoms, and the presence of a more or less movable bean-shaped tumor, palpation of which produces a peculiar sickening pain. The patient should be examined, first, lying on the back, when the presence of a movable tumor, which is forced downward by inspiration and slips with a quick movement from beneath the examiner's fingers in the upward direction with expiration, can usually be determined with ease; then on the healthy side, and finally in the standing position, in order to demonstrate the absence of the kidney from its normal position in the loin. A recess in the loin (Morris) is sometimes well marked, replacing the normal contour. Percussion over the loin gives a resonant note. The respiratory movements influence the position of the organ in all postures of the body. The urine in uncomplicated cases is normal. The condition is to be differentiated from small ovarian tumors, distended gall-bladder, and tumors of the omentum and mesentery. Enlargement of the head of the pancreas may simulate a movable kidney.

The **treatment** consists in the avoidance of such active movements as bring on the paroxysms of pain. An apparatus consisting of a snugly fitted belt and pad will sometimes give relief to the symptoms in the milder cases, without, however, necessarily retaining the organ in its normal position.

Nephrorrhaphy should be performed in any case in which the diagnosis is assured and the distressing symptoms are persistent (see page 225).

Hydronephrosis.—This is an aseptic dilatation of the pelvis of the kidney by urine, the flow of the latter being obstructed by mechanic means. If infection takes place, the condition is converted into a **pyonephrosis** (see page 213). The mechanic obstacle may be situated in the ureter, bladder, or urethra. The disease may be congenital itself or it may occur after the kidney becomes functionally active from a congenital cause. The congenital causes almost always involve the ureter, which may be imperforate, or obstructed by an anomalous branch of the renal artery, or angulated in an abnormally mobile kidney (Cole, Israel). **Acquired causes** include (1) compression of the ureter by malignant tumors in the small pelvis (90 per cent, Morris); (2) diseases and injuries of the wall of the ureter; (3) angulation of the ureter, due to floating kidney and leading to valve formation at the pelvic end of the ureter (Fenger); (4) obstruction within the canal of the ureter, such as an impacted calculus or a foreign body, or blood-clot, rarely a neoplasm; (5) inflammatory exudations (pelvic cellulitis), abdominal tumors, carcinoma of the uterus, or occlusion of the vesical orifice by a growth within the bladder. Those involving the bladder and urethra relate mainly to obstructive diseases of these parts. The affection may be **double.**

The dilatation extends to the calyces and pouches form filled with fluid at the site of the calyx, which communicate with the cavity of the pelvis of the organ; or one or more of these may be isolated from the latter by obliteration of the original orifice of communication. In other cases the pelvis alone may be involved in the dilatation. The wall of the sac representing the stretched, thinned, and atrophied parenchyma is usually thin and translucent.

The **symptoms** at the commencement are vague and indefinite and consist of dull pain in the loin, with a diminution of the amount of urine and sometimes frequent micturition. Fever is absent in uninfected cases. When the dilatation has progressed sufficiently far, a palpable tumor is present. In impacted calculus a history of an attack of renal colic can usually be obtained. Sudden diminution in the size of the tumor, coincident with the evacuation of an unusually large amount of urine, constitutes the condition known as **intermittent hydronephrosis;** this arises from angulation of the ureter associated with a movable kidney. The attacks are characterized by severe paroxysms of pain and their constant repetition leads to permanent obstruction.

The **diagnosis** is established by the above symptoms and by the presence of a distinctly fluctuating tumor in which no solid masses can be felt (Le Dentu). Exploratory puncture, which is attended with risk and should be employed only as a last resort in making the diagnosis, reveals a fluid which, if any portion of the kidney remains functionally active, will contain urea or uric acid, or the fluid may be only that which is found in simple retention cysts.

The **treatment** consists in removal of the cause in recent and acquired cases where this is possible. In cases of **double hydronephrosis,** incision, drainage, and the establishment of a permanent fistula in the loin are indicated. In unilateral cases incision and drainage may be first practised, and a nephrectomy subsequently performed, if demanded.

In intermittent hydronephrosis the symptoms may be temporarily relieved by inversion of the patient, conjoined with manipulation having for its object the straightening of the angulated ureter. Radical cure will demand fixation of the kidney (see Nephrorrhaphy, page 225).

Cysts of the Kidney.—Cysts of the kidney may be **isolated,** or those in which unchanged portions of the kidney structure separate the cysts when multiple, and **conglomerate,** or those in which the parenchyma has given place to a large number of cysts, varying in size from those which are microscopic to those as large as a grape. Isolated cysts are thought to have their origin in dilatation of a glomerule or of a tubule. One kidney only may be affected. Conglomerate cysts, in addition to obstruction of the tubules, may arise, like ovarian cystomas, from degenerative epithelial disease. This variety may be of congenital origin and is frequently double.

The **symptoms** in isolated cysts are those arising from the pressure of the tumor on the surrounding viscera. The tumor is firm, elastic, and globular. When large, it may be mistaken for an ovarian cystoma. In conglomerate cysts, or **large polycystic kidney,** in addition to the pressure symptoms, there will be added those arising from degenerative disease of the kidney substance. The shape of the tumor, when this can be made out on palpation, is that of the normal kidney, with a lobulated surface. Edema of the lower extremities may arise from pressure on the large abdominal veins.

The **treatment** of isolated cysts consists of (1) incision, with drainage in the lumbar region and the stitching of the cyst wall to the skin edges; (2) extirpation of the cyst and suture of the wound in the parenchyma of the kidney (Tuffier); (3) nephrectomy, if the presence of another kidney can be demonstrated. There is no surgical treatment for conglomerate cysts, except in the rare instances in which they are beyond doubt unilateral, when nephrectomy may be performed.

Hydatid cyst of the kidney is rare compared with the occurrence of this disease in other organs. It occurs almost exclusively single. The tumor may vary in size from that of an orange to very large dimensions. The cyst may rupture into the pelvis of the kidney, giving rise to symptoms of nephritic colic, and discharge by way of the bladder; or the contents may find exit into the intestine, stomach, or lung, and give rise to characteristic symptoms. Suppuration of the cysts may take place, giving rise to fever, etc. Exploratory puncture may assist in the diagnosis. This, however, should not be performed without preparation for immediate radical operative treatment. Finally the cyst may disappear spontaneously, as in the case of hydatid cysts in other organs, after death of its contents. The **treatment** consists of (1) incision, excision of as much of the cyst wall as possible, and suture of the edges of the remaining portion of the wound in the overlying parts; (2) nephrectomy, in case the kidney is wholly destroyed.

Solid Tumors of the Kidney.—**Benign** tumors of the kidney include lipomas, fibromas, and adenomas. Lipomas are very rare and are to be distinguished from **circumrenal lipomas. Fibromas** usually occur as small white nodules near the bases of the pyramids. **Adenomas** are, in some instances, of accessory renal origin and are believed by some to have a marked tendency to malignancy.

Malignant diseases include **carcinoma,** of which encephaloid is the most common variety, and **sarcoma.** Carcinoma occurs by preference late in life. Myosarcomas occurring in the renal region are probably exclusively congenital. They are extrinsic in origin and strictly nonrenal (Sutton).

Carcinoma of the Kidney.—The epithelium of the uriniferous tubules forms the starting-point for carcinoma of this organ. The renal tissue is gradually transformed into the structural elements of the disease, and the growth, after involving the pelvis of the kidney, invades the ureter and may reach even the bladder. It is far less frequently observed than sarcoma of the kidney, is very rare before middle life, and is confined exclusively to one kidney.

Cancer of the kidney is attended by a high mortality, operative efforts failing to prolong life beyond a year, even in the most successful cases. The mortality of the operation itself is over 50 per cent.

Cancer of the kidney is secondary to cancerous disease elsewhere in the proportion of five to one, as compared with primary disease (Morris). In its secondary form it is more common in females than in males.

Sarcomas of the Kidney and Adrenals.—These occur, as a rule, during the first five years of life, or during the period between thirty and fifty. Those which occur early in life are most frequently found in the pelvis of the organ, while those of the later period are more likely to affect the capsule. They are yellowish-white on section, with cystic spaces due to degenerative changes present in the larger growths. Both the round-celled and the spindle-celled forms are present, the latter often possessing transverse striae. In some growths the sections show a tubular arrangement resembling renal tubules. The tubules of the growth are probably derived from the kidney structure itself. The ureter is rarely involved in the disease, or even compressed, which fact explains the absence of blood in the urine in the majority of cases, and of renal obstruction as well. The renal vein is early involved, and the growth extends into the vena cava, which, becoming obstructed, causes edema of the lower limbs. Detached portions reach the capillaries of the lung, where they give rise to secondary deposits. The disease may be bilateral and advance more rapidly in one organ than in the other (Abbe). The mortality following nephrectomy for sarcoma of the kidney is not less than 50 per cent, and of those surviving the operation at least 90 per cent die from recurrence at any time from a month to a year.

In adults the growth extends from the capsule to the tissue of the kidney proper. Care should be taken, however, in studying cases in the adult, to exclude perirenal sarcomas. Exclusive of the last named, the disease is much less frequently observed in adults than in children.

Renal sarcomas may exhibit, on microscopic examination, the structure of the adrenals (Grawitz). This has led to the belief that, in some instances at least, these growths have their origin in accessory adrenals. The prognosis in the class of cases in which this structure is demonstrated to exist appears to be less grave after nephrectomy (Sutton).

Adrenal sarcomas may attack one or both organs; the latter particularly in children, in whom the sarcomas may attain the size of a cocoanut. An overgrowth of hair on the surface of the body and a coppery hue of the skin are more or less associated features. As in the case of renal sarcomas, these tumors grow rapidly, disseminate readily, and quickly destroy life.

The **symptoms of malignant disease of the kidney** include recurrent hematuria of renal origin and the presence of a firm and more or less movable tumor in the region of the kidney. Hematuria is absent in one-fourth of the cases of carcinoma, one-half of the cases of sarcoma, and three-fourths of the malignant tumors of children (Tuffier). The tumor varies in size, from a size slightly above that of the normal kidney in the carcinomas of adults to the enormous proportions that the sarcomas attain in children. The tumor may present itself more prominently in front, beneath the free border of the ribs, than in the loin. In adults pain in the lumbar region is to be added to these symptoms. Renal colic may be caused by the passage of blood-clots. Emaciation and cachexia occur late in the disease. Pressure symptoms from a large tumor may be present in both malignant and benign cases. In cancer early involvement of the lumbar retroperitoneal glands occurs.

The **diagnosis** of solid tumors of the kidney is always difficult. Renal tumors almost invariably present a rounded outline; they may fill up the natural hollow in the loin, but rarely project backward, expanding almost exclusively in an anterior direction. The large intestine is always in front of the tumor. There is no line of resonance, or space in which the finger-tips can be pressed between the kidney and the spinal column. They are to be differentiated from splenic and hepatic tumors by their comparatively limited up-and-down movements in expiration and inspiration. **Palpation** of the kidney is performed by placing one hand flat on the abdomen, transversely in front, and the other longitudinally in the iliocostal space just outside the erector spinae muscles, with the finger-tips close below the free border of the ribs. The palpation should be done during expiration, while the patient's attention is diverted.

The presence of hematuria of renal origin and the rapidly growing tumor in the loin, together with pain, are always strong evidences of malignant disease. Clinically, differentiation between carcinoma and sarcoma is impossible, except in cases where tumor cells are found in the urine. Finally, in view of the importance of an early diagnosis in malignant cases, exploratory incision, either lumbar or abdominal, preferably the former, should be made in doubtful cases.

Treatment.—In view of the rapid generalization in malignant disease of the kidney, operative measures, to be successful, must be undertaken early. Unfortunately, it is, as a rule, too late when the trustworthy evidence of the disease is present, *i. e.*, a well-marked tumor in the flank, conjoined with hematuria. While nephrectomy is usually contraindicated in children because of the late stage of the disease when discovered, it has been successfully performed (Abbe). Under any circumstances of malignant disease of the kidney this, though a hazardous procedure, is the only operative treatment permissible.

The indications for operative interference in benign tumors of the kidney relate to the size of the tumor and the inconveniences occasioned by its presence.

OPERATIONS ON THE KIDNEY

Two routes are available for exposure, exploration, incision, or removal of the kidney, namely, through the loin or across the peritoneal cavity. When available, the first is to be preferred as the less dangerous; or the two may be advantageously combined in certain cases.

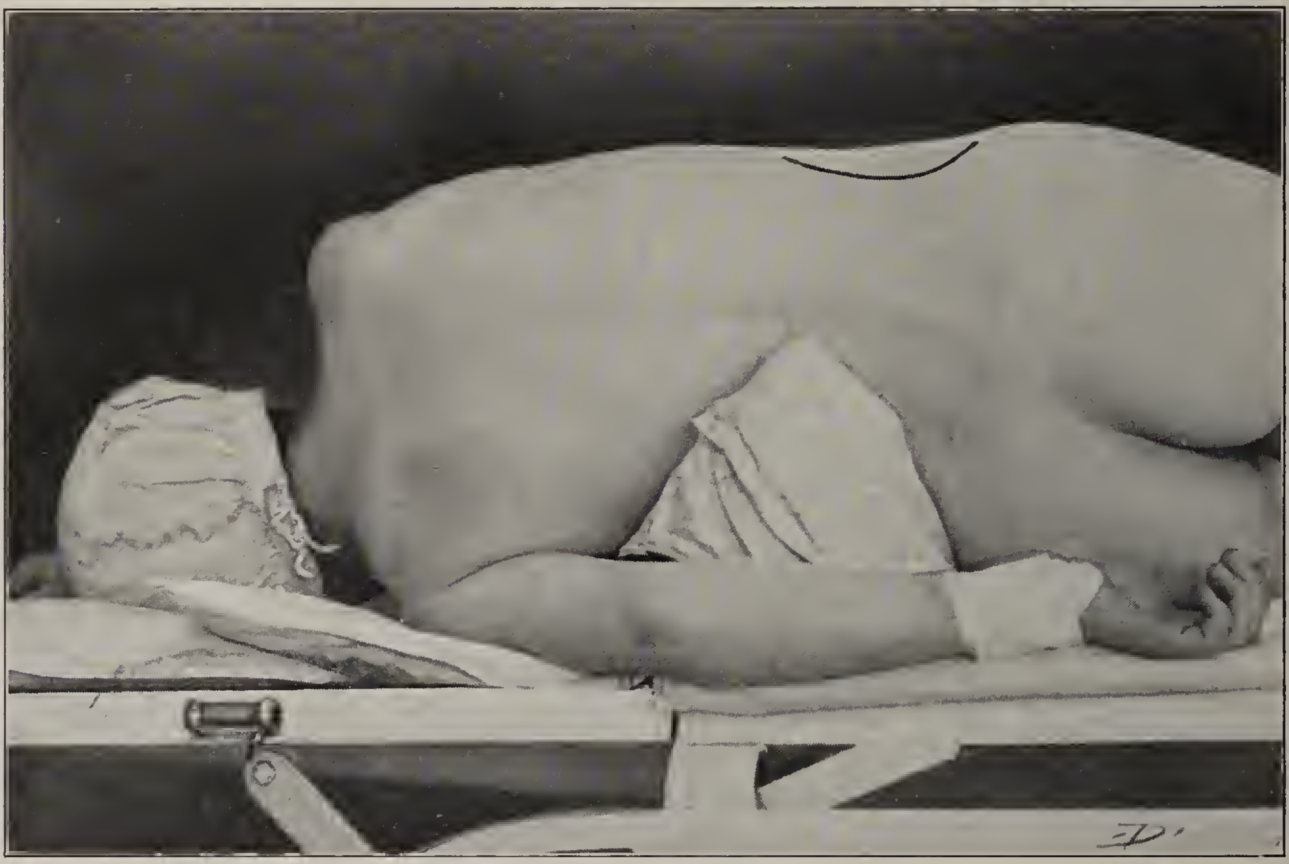

Fig. 562.—The Curved Costo-iliac Incision.

The methods of **lumbar incision** include the following: (1) The curved costo-iliac incision (Fig. 562), which commences over the eleventh rib, extends along the lateral border of the sacrolumbalis muscle to the crest of the ilium, from which point it may be curved directly forward for two inches or more, according to the requirements of the case. This divides the skin, the subcutaneous tissue, the latissimus dorsi muscle, and the lumbar aponeurosis.

The kidney is reached by blunt separation of the fascia covering the adipose capsule of the kidney in front of the quadratus lumborum. (2) The oblique incision commencing at the lateral border of the sacrolumbalis muscle just below the twelfth rib above, and passing obliquely downward and forward to the juncture of the outer and middle thirds of Poupart's ligament below (Bergmann, Czerny). (3) The retroperitoneal lumbo-abdominal incision (König), which extends vertically along the lateral edge of the sacrolumbalis muscle to the crista ilii, from which point it curves toward the umbilicus and ends at the outer edge of the corresponding rectus abdominis muscle. (4) A vertical incision 3½ to 4 inches long, beginning at the eleventh rib and running parallel to the outer edge of the sacrolumbalis muscle (Simon). (5) The transverse lumbar incision commencing about a quarter of an inch below the border of the ribs, and extending anteriorly from the edge of the sacrolumbalis muscle to the axillary line (Braun, Kocher). The first one of these suffices for the average case. The second or third may be employed in cases of large tumors and where more room is required. The fourth should be employed for exploratory purposes, simple nephrotomy, etc. It may easily be converted into the first or costo-iliac incision. The fifth is useful when the identification of a second kidney or its exploration is necessary. The surgeon defines the twelfth rib in deepening the upper extremity of these incisions in order to avoid opening the pleura. If this is not available, the last dorsal spine is used as a landmark.

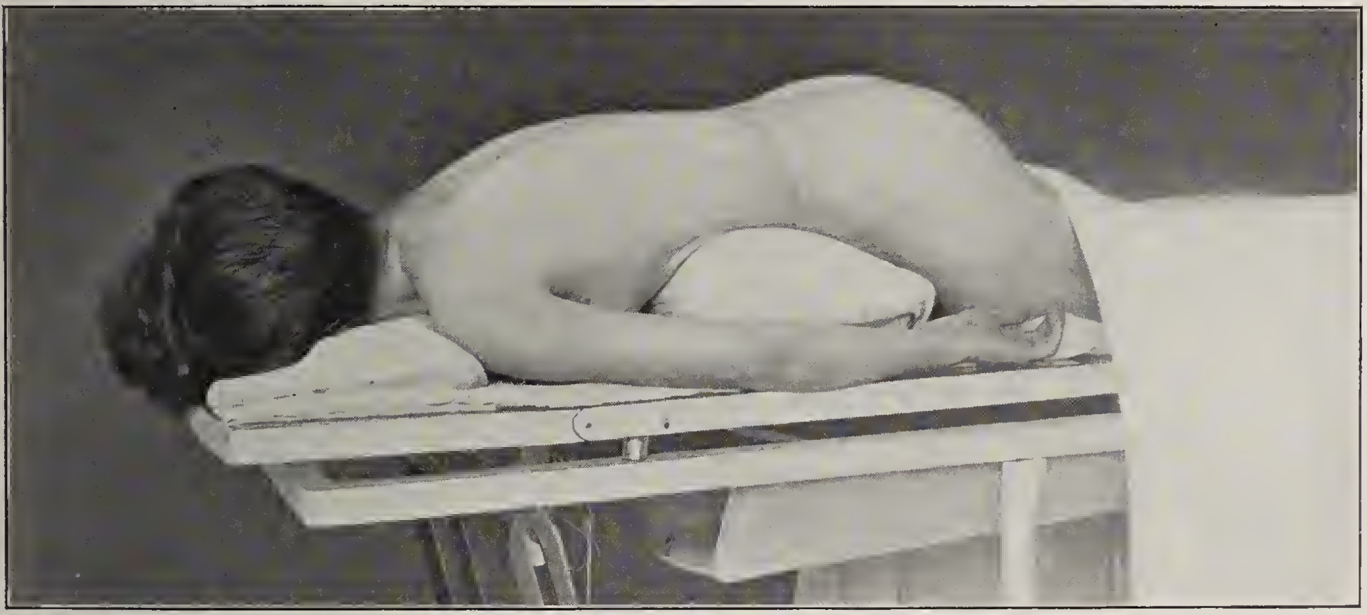

Fig. 563.—Position for Operation on Both Kidneys.

The **anterior abdominal** or **transperitoneal incision** is really a lateral abdominal section, the incision being made through the linea semilunaris. While the organ may be reached through a median incision, this is not so convenient as the incision along the edge of the rectus muscle, unless there is a question as to which kidney is to be attacked.

When the lumbar incision is employed, the patient should lie on the healthy side, beneath which should be placed a round air-cushion in order to make the lumbar region of the diseased side as prominent as possible (Fig. 562). When both kidneys are to be operated on, the patient is to be placed in the prone position, with an air-cushion between the abdomen and the operating table (Edebohls, Fig. 563).

Nephrotomy.—The kidney is exposed by a vertical lumbar incision. The latter is deepened layer by layer until the aponeurosis of the transversalis or middle fascia is reached. This is incised, the incision exposing the outer border of the quadratus lumborum muscle; after the latter is retracted toward the spine, the thin anterior layer of the lumbar fascia is divided and the perineal fat exposed. The fatty capsule is torn through and the middle and lower portions of the posterior surface of the kidney are exposed. Its connections are loosened, except in the neighborhood of the hilum, and the organ carefully brought down and delivered into the wound. The further steps will depend on the conditions present. The kidney is incised, abscess or cyst cavities evacuated and the interior scraped; if separate pouches exist all septa must be divided. The edges of the sac may be stitched to those of the wound in the skin. Drainage is effected by large rubber tubes.

Nephrolithotomy.—After exposure of its posterior surface the kidney is to be exposed and examined for signs of the presence and location of a calculus by the following methods: (1) The touch, all of the accessible portions of the kidney being thoroughly palpated. (2) The introduction of a needle having a point somewhat dulled so as to avoid injury to the larger vessels. This method is without danger and it is also an efficient method of exploration when systematically carried out. The needle may penetrate the parenchyma as well as the wall of the pelvis. (3) Incision of the kidney and exploration of the pelvis with the finger, or a small sound, or both, if palpation and the use of the needle as above described have failed. The hemorrhage during this process may be controlled by digital pressure on the renal vessels or by the use of Cumston's clamp (Fig. 564).

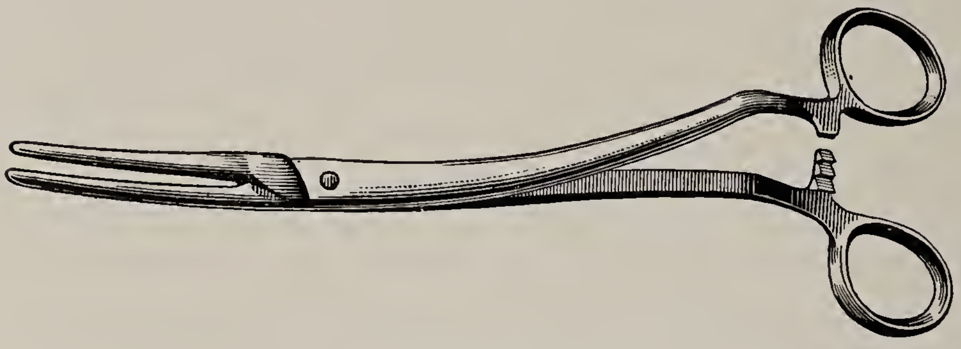

Fig. 564.—Cumston's Clamp for Grasping the Pedicle in Nephrotomy.
The blades should be covered with rubber tubing.

In order to avoid excessive bleeding, the incision for the removal of the stone is made along the white line marking the junction of the two halves of the circulatory system of the organ (Max Brödel), when this can be identified, and through the substance of the organ. This incision is similar to the postmortem cut, and may divide the kidney to the pelvis of the organ, if necessary. The wound in the kidney is subsequently closed with through-and-through mattress sutures of catgut, in order to control the hemorrhage (Tuffier). The stone is removed by forceps; if large, it may be broken into pieces, or it may be necessary to open up intervening septa or separate pouches. Provision should be made for assuring the patency of the ureter (sounding, or catheterization of the ureter from the pelvis of the kidney), if this is found to be obstructed by a calculus or fibrinous clot. The latter may sometimes be forcibly washed into the bladder (Lange). The external wound is partially closed and drained.

Nephrectomy.—The costo-iliac incision suffices for simple nephrectomy and in cases of small and medium sized growths. Either the Bergmann-

Czerny or the König incision is to be employed in the case of large tumors. The transverse incision offers an advantage in that its anterior extremity can be carried sufficiently far to permit the opening of the peritoneal cavity and the identification of a second kidney (Kocher). After exposure of the organ, the fingers are worked around its convex border and two extremities, and all attachments separated until the pedicle, which consists of the ureter and renal vessels, is reached. When possible, the renal artery is isolated and tied separately. The pedicle proper is to be ligated in sections with braided catgut, the ligature being passed by means of a large aneurism needle or the ligature carrier (Fig. 468). It may be necessary in some instances to ligate the pedicle *en masse*, and exceptional conditions may arise which will make it necessary to rely on strong clamp forceps. The space from which the organ has been removed should be cleansed, partially closed by sutures, and packed with zinc oxid or plain sterile gauze. Iodoform should not be used in this situation. Should the kidney be found lying in a mass of matted and adherent structures so that there appears to be danger of injuring the colon or the vena cava, or likelihood of entering the peritoneal cavity, it is well to incise the capsule proper and to shell the kidney out of this down to the pedicle, which is treated as above described.

In **abdominal nephrectomy** the abdomen is opened in the corresponding linea semilunaris, the intestines held out of the way with warm gauze compresses, the peritoneum incised behind and on the outer side of the colon, when practicable, so as to avoid interference with the blood-supply of the latter, the peritoneum stripped from the kidney, and the vessels secured at once. The enucleation is effected mainly by the fingers, the remainder of the pedicle secured, the kidney cut away, and lumbar drainage of the retroperitoneal space provided for by a counter-opening in the flank. The gap in the peritoneum is sutured with catgut and the abdominal wound closed.

Partial Nephrectomy.—Excision of diseased portions of the kidney may be performed for simple and hydatid cysts, small benign tumors, and even for small malignant growths when doubt exists as to the presence of another kidney. The operation has also been performed for tuberculous disease limited to a small portion of the kidney, traumatic abscesses, calculous pyonephritis, renal fistula, and injury. The operation is performed through the curved costo-iliac incision. The organ is drawn out on the surface of the loin and the renal artery compressed while the diseased part is being excised. Small abscesses and tuberculous foci are to be incised and scraped away. The cut surfaces should be drawn together with through-and-through catgut sutures and the external wound drained with a large drainage-tube reaching down to the kidney.

Nephrorrhaphy.—The curved costo-iliac incision is employed. The renal fat is separated by the scissors and the proper capsule of the kidney incised for about two inches and a half, and separated from the kidney structure for about half an inch to each side of the incision in the capsule. At the same time an assistant forces the organ toward the operator by pressure on the abdomen in front. The kidney is now pushed in front of the diaphragm until only its lower portion remains visible. The middle portion of the capsule is sutured to the anterior surface of the quadratus lumborum muscle by means of several fine silk sutures; the peritoneum is united with the fibrous capsule laterally

(Hahn). The silk sutures are cut short and buried and the external wound closed. The patient is kept in the recumbent position for four weeks.

Goelet introduced the method of passing the sutures beneath the capsule at right angles to the vessels and leaving bridges of suture material on the surface of the capsule continuous with the sustaining sutures (Fig. 565). Brödel has suggested a somewhat different arrangement of the sutures, though on the same principle (Fig. 566). The latter has shown that this arrangement of the sutures will bear from three to four times as much strain without tearing out as when they are passed in the ordinary manner as through-and-through sutures. In Goelet's operation the sutures are of medium-sized silk and pass out through the structures of the back, to be secured over bolsters or tied across the external wound. In Brödel's method the sutures are of somewhat finer silk and are passed through the quadratus lumborum muscle, tied and cut off close (buried sutures, Fig. 567). In both operations the wound in the loin is closed without drainage. In either case the formation of adhesions will be enhanced by making superficial scarifications of the surface of the capsule after the sutures are applied.

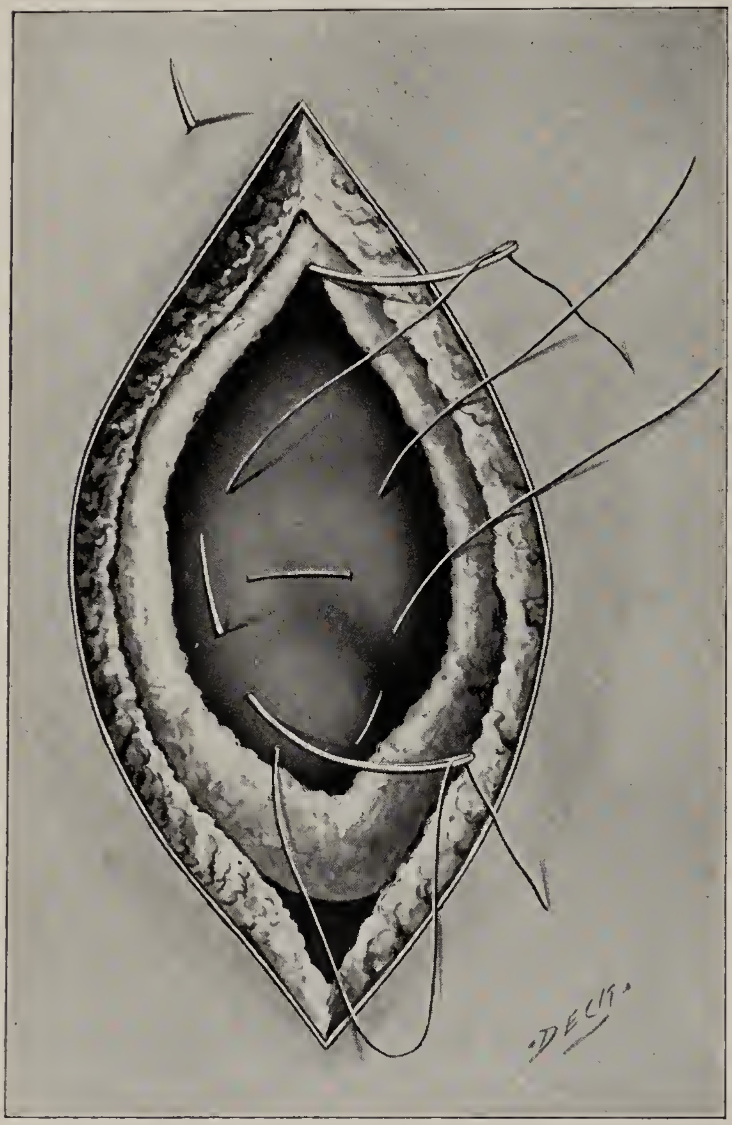

Fig. 565.—Goelet's Method of Fixation of the Kidney.

The lowermost of the two sustaining sutures is placed at the lower pole of the organ.

Costal Fixation of the Kidney (Hoffmann).—This is accomplished as follows: A lumbar incision is made from the eleventh rib along the lateral edge of the sacrolumbalis muscle to the crest of the ilium. The kidney is freed from its fatty capsule. The twelfth rib is now exposed and the kidney reduced to its normal position. At the point where the posterior surface of the organ lies in front of the twelfth rib a double door or I-shaped incision is made, and the two rectangular flaps thus formed are loosened and rolled upon themselves laterally. These rolls are fixed with sutures. The supporting sutures, of strong silk, are passed, each through the corresponding roll several times, and then through the intercostal space from in front backward around the rib, and knotted. The object of rolling the edges of the capsule is to prevent the cutting or the tearing out of the supporting sutures. The exposed portion of the kidney favors attachment at the twelfth rib. The adipose capsule, the muscles, and the skin are sutured separately. A compression cushion on the anterior abdominal wall of the corresponding side is included in the dressings. The patient should maintain the horizontal position for three weeks.

Decapsulation of the Kidney.—This operation has been proposed for the cure of chronic Bright's disease (Edebohls). The operation is performed with the patient lying prone on the table, an air-cushion underlying and supporting the abdomen (Fig. 563). The vertical incision along the outer edge of the sacrolumbalis muscle is employed (costo-iliac incision). The kidney is delivered through the wound if possible. The capsule proper of the kidney is divided on a director along the entire length of its convex external border, including the extremity of each pole. Each half of the capsule is in turn stripped from the kidney in the direction of the pelvis until the entire surface of the organ is denuded. The kidney tissue is sometimes very friable and the capsule is adherent; hence care is necessary to avoid tearing the former. The stripped off capsule is cut away, the kidney dropped back, and the wound closed. If the kidney cannot be delivered, the capsule proper is stripped off by the fingers in the bottom of the wound and excised as far as possible. The operation has not been generally accepted by the profession up to the present time.

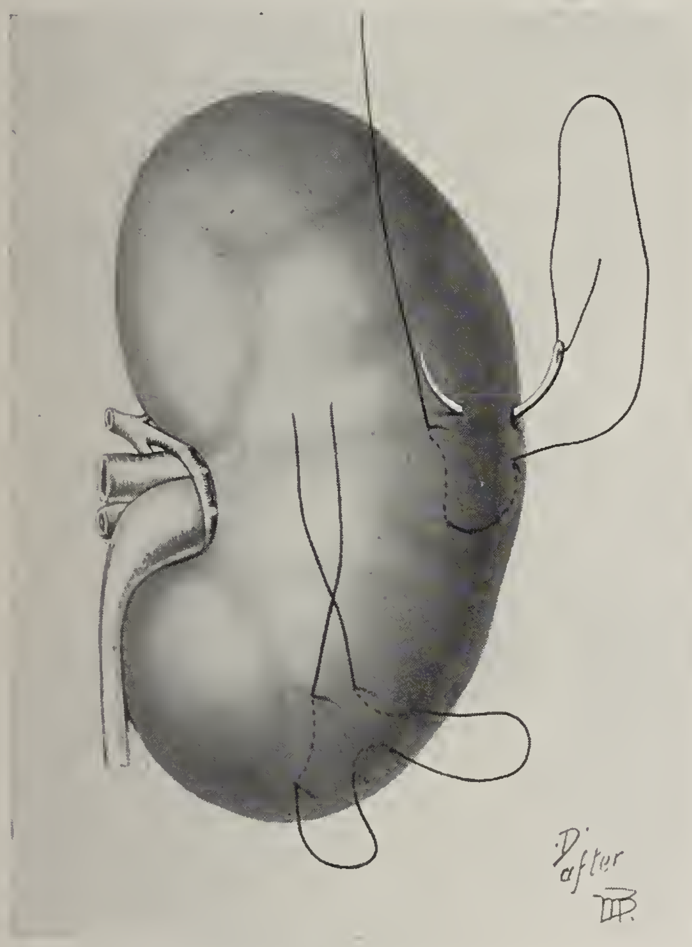

FIG. 566.—BRÖDEL'S METHOD OF FIXATION OF THE KIDNEY.
Applying the sutures.

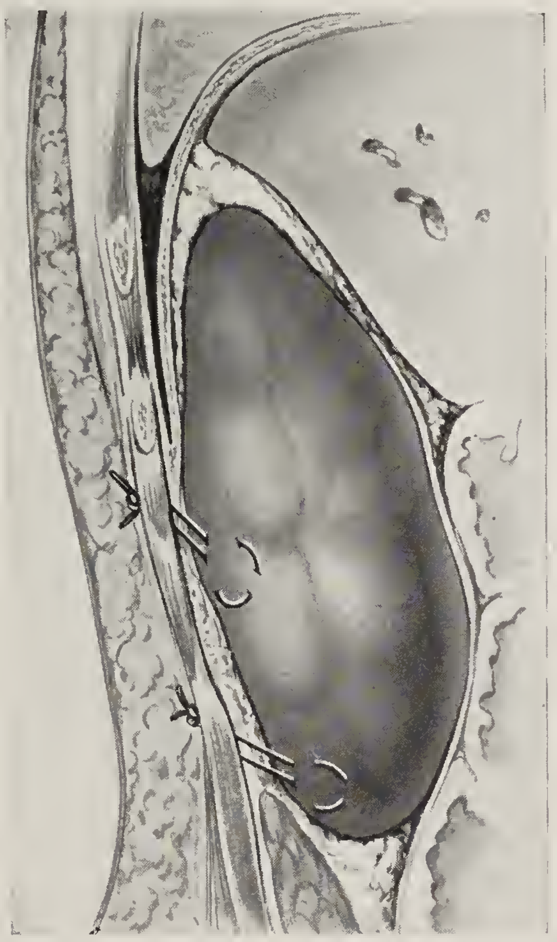

FIG. 567.—BRÖDEL'S METHOD OF FIXATION OF THE KIDNEY.
The kidney is held in position by buried silk sutures.

THE PELVIS

Fractures of the Bones of the Pelvis.—Fractures of the margins and processes of the pelvic circle occur from direct force externally applied. The continuity of the structure involved is not, as a rule, disturbed. The spinous processes of the sacrum and the crest of the ilium may be broken, though rarely. Riedinger claims to have observed fractures of these parts by violent contraction of the gluteal muscles. Other than the application of a simple hip binder and rest in bed, these fractures require no special treatment. Accurate apposition of the fragments is neither possible nor absolutely necessary. Though the repair takes place, as a rule, by means of connective tissue, very slight, if any, disturbance of function follows these injuries.

Fractures passing through the pelvic circle, however, are of far greater importance, owing to the arched shape of the circle and the amount of force required to produce them. A force sufficient to overcome the strong resistance of the pelvic circle usually causes two lines of separation. These lines may follow the synchondroses of the pelvis, producing dislocations of the pelvic bones. If fracture takes place, however, one line passes through the ilium from its crest to the sciatic notch, while the other extends from the iliopectineal eminence downward through the horizontal ramus of the pubis, the obturator foramen, and through the ascending ramus of the ischium. The obturator membrane is not necessarily torn. Two reasons are advanced to account for the frequency of the fracture along these lines: (1) they represent the lines of least resistance; (2) these injuries usually result from falls on the extended lower extremity in which the force is transferred from the femur to the acetabulum and thence to the adjacent portion of the pelvic ring. The second line of fracture may be duplicated on the opposite side, with displacement of the symphysis pubis toward the bladder. Fracture of the acetabulum alone is exceedingly rare. A brief reference is made by Krönlein to a case in which both acetabula were crushed in by a fall on the feet, the head of each femur being driven into the pelvis.

Diagnosis.—This rests essentially on the tenderness on palpation from without, and the symptoms obtained by examination from the rectum or the vagina. **Retention of urine** is a further, though not entirely trustworthy, symptom. This occurs soon after the injury and may continue several days or longer, according to the cause. It may be due to effusion of blood surrounding and compressing the neck of the bladder; it may also result from paralysis of the muscular apparatus of the bladder caused by contusion of the pelvic ring. The ease or otherwise of the introduction of the catheter will decide this point. Coincident or resulting injury to the urethra is followed by urinary extravasation (see page 267).

Gunshot wounds of the pelvis and injuries involving the entrance of splinters and other foreign bodies, as well as "buffer" and other severe crush accidents, form a class by themselves, the importance of the traumatism depending not so much on the fracture of the pelvic bones as on injuries to contained organs.

Prognosis.—The prognosis depends less on the fracture of the bones than on accessory or coincident injuries to the contained organs. Simultaneous injury to the bladder, urethra, peritoneum, colon, or small intestine greatly increases the gravity in individual cases. Simple invasion by a bullet of the iliopsoas muscle may result fatally from extensive phlegmonous inflammation. Injury to the iliac artery and vein, as a rule, terminates in death.

Treatment.—While complications of fractures of the pelvic bones must be met in various ways, according to the indications, the fracture itself needs only to be left undisturbed, with ice-bags and anodynes to allay the pain. Where the injury results from a fall from a height, the patient striking on the feet, the portion of bone between the lines of fracture being driven into the pelvis, a weight and pulley extension applied to the femur of the corresponding side is indicated. Bony consolidation takes place in about six weeks.

Dislocations of the Bones of the Pelvis.—These are exceedingly rare, owing to the peculiar anatomic nature of the joints of the pelvis (symphysis pubis and sacroiliac synchondroses). These are characterized by strong ligamentous attachments, an absence of fibrous cartilaginous attachments, and exceedingly slight mobility. The sacroiliac synchrondroses, in addition, are marked on the joint surfaces by a peculiar roughness. The only normal movement of the pelvic bones is that which occurs when the sacrum is forced downward between the iliac bones by the carrying of heavy weights, and this is scarcely appreciable.

Dislocation of the sacroiliac joint may arise from force vertically applied, the sacrum being parted from both iliac bones, or from strong lateral pressure, the iliac bone overriding the sacrum. In the latter case either there is simultaneous dislocation of the pubic symphysis, or a vertical fracture separates the horizontal ramus of the pubis and the ascending ramus of the ischium. Unilateral dislocation of the sacroiliac joint, without simultaneous dislocation of the symphysis pubis or fracture, is of rare occurrence, though Salleron claims to have observed a case. Finally, all the pelvic joints may be simultaneously dislocated, the force under these circumstances, however, being usually sufficient to cause death.

During the last months of pregnancy the pelvic articulations become loosened, and during delivery the child's head impinges against the pelvic circle from within and does not meet with the same resistance offered when the force is applied from without. Cases have been observed in which all the joints of the pelvis have been found to have yielded during difficult labors. The most common of these accidents, however, is a more or less pronounced diastasis of the symphysis pubis.

The **diagnosis, prognosis,** and **treatment** of these injuries rank with those of pelvic fractures, since they are quite analogous in many respects. In pronounced cases complete restitution is hardly possible, as a rule, and, owing to the rupture of the strong ligaments, retention is still more difficult. The treatment usually resolves itself into maintaining the recumbent posture, avoiding pressure sores, and using the catheter.

Dislocations of the bones of the coccyx, sometimes erroneously diagnosed as fractures, are of not uncommon occurrence. The diagnosis is made by grasping the coccyx, with the index-finger in the rectum and the thumb placed externally. The torn ligamentous structures are slow to unite and most frequently fail of repair altogether. The persistence of the dislocation often leads to such disturbances as pain on defecation, walking, or sitting, which are sometimes, but not always relieved, particularly in nervous women, by resection of the displaced portion. The operation is most conveniently performed with the patient in the exaggerated lithotomy position (Figs. 568 and 569).

Inflammations of the Pelvic Joints.—Inflammations of the pelvic joints may occur during the postpuerperal period in connection with septic pyemic states originating in the uterus and vagina. The physiologic changes which the pelvic bones and the ligamentous structures undergo during pregnancy predispose to this inflammation. Metastatic suppurative foci may also occur in the softened bones themselves. The symphysis pubis may retain an abnormal mobility for quite a long time, even after normal delivery. **Sacrocoxalgia** or **sacrocoxitis** is a name given to a nonpuerperal form of inflammation of the iliosacral joints. It attacks most frequently males between the ages of twenty and thirty-five years. It is caused by (1) extension of tuberculous osteomyelitis; (2) gonorrhea; (3) traumatism.

Suppurative sacrocoxitis leads to the formation of abscesses, which, as a rule, pass downward along the posterior surface of the psoas to the sciatic notch and make their appearance beneath the gluteal muscles. Or, they may follow the usual course of a psoas abscess. Occasionally, when the powerful ligamentous bands between the sacrum and the ilium are softened by tuberculous infection and inflammation, they follow a more favorable course and point directly backward beneath the skin. These abscesses should be promptly opened and their bony walls, as well as the soft parts, thoroughly curetted and drained. Formal resection of the sacroiliac joints is scarcely

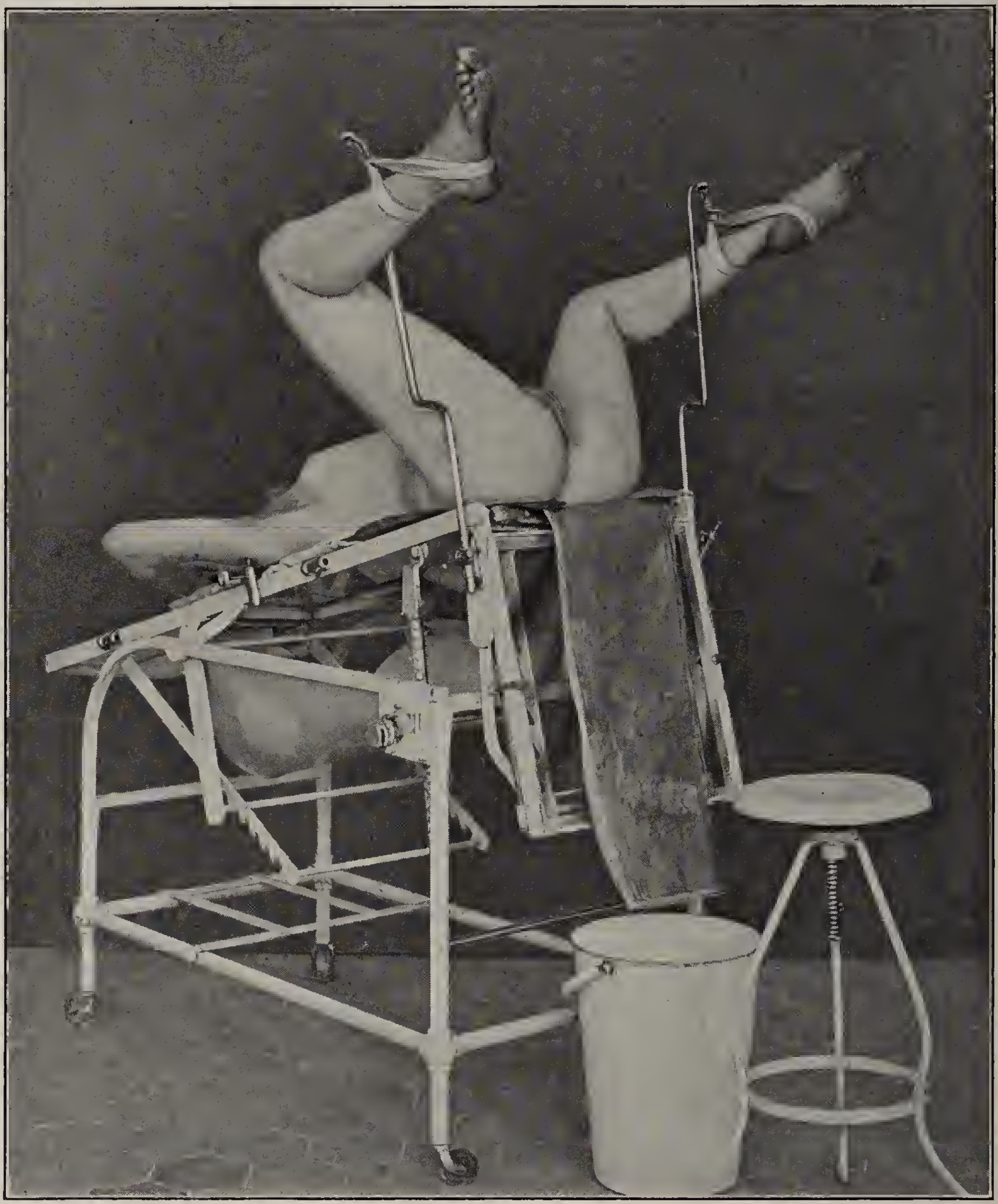

Fig. 568.—Resection of the Coccyx.
The patient in the exaggerated lithotomy position.

permissible, on account of the disturbances of locomotion which are almost certain to follow.

Rheumatic sacrocoxitis is the condition present in many of the intractable cases of supposed **lumbago.** Similar inflammations are observed in the **sacrococcygeal joint,** and in the joints between the bones of the coccyx.

Inflammations of the Pelvic Bones.—**Traumatic inflammation of the pelvic bones** occurs most frequently in connection with war surgery from gunshot and shell wounds. In former times the failure of complete penetration and the occurrence of extensive splintering led to widespread infection and suppuration and a high mortality. With the modern bullet a clean-cut perforation is made, which serves as a drain, and much less damage is done to the bony parts; hence these untoward effects are less frequently observed.

Phlegmonous inflammation following perforation of the ilium and invasion of the psoas muscle is very difficult to deal with, the suppurative process extending downward between the muscle and the bone. When once fully developed, it affords an unfavorable prognosis on account of the difficulties attending attempts to obtain free drainage and apply antiseptic treatment. Sometimes through drainage may be obtained by enlarging the wound of entrance, and, with the finger passed through this as a guide, making a counter-opening with a blunt instrument, after the skin between the tuberosity of the ischium and the anal orifice has been incised freely. Drainage is thus effected through the ischiorectal space. Drainage-tubes may also be placed so as to drain the lesser pelvis, emerging near the point of the coccyx.

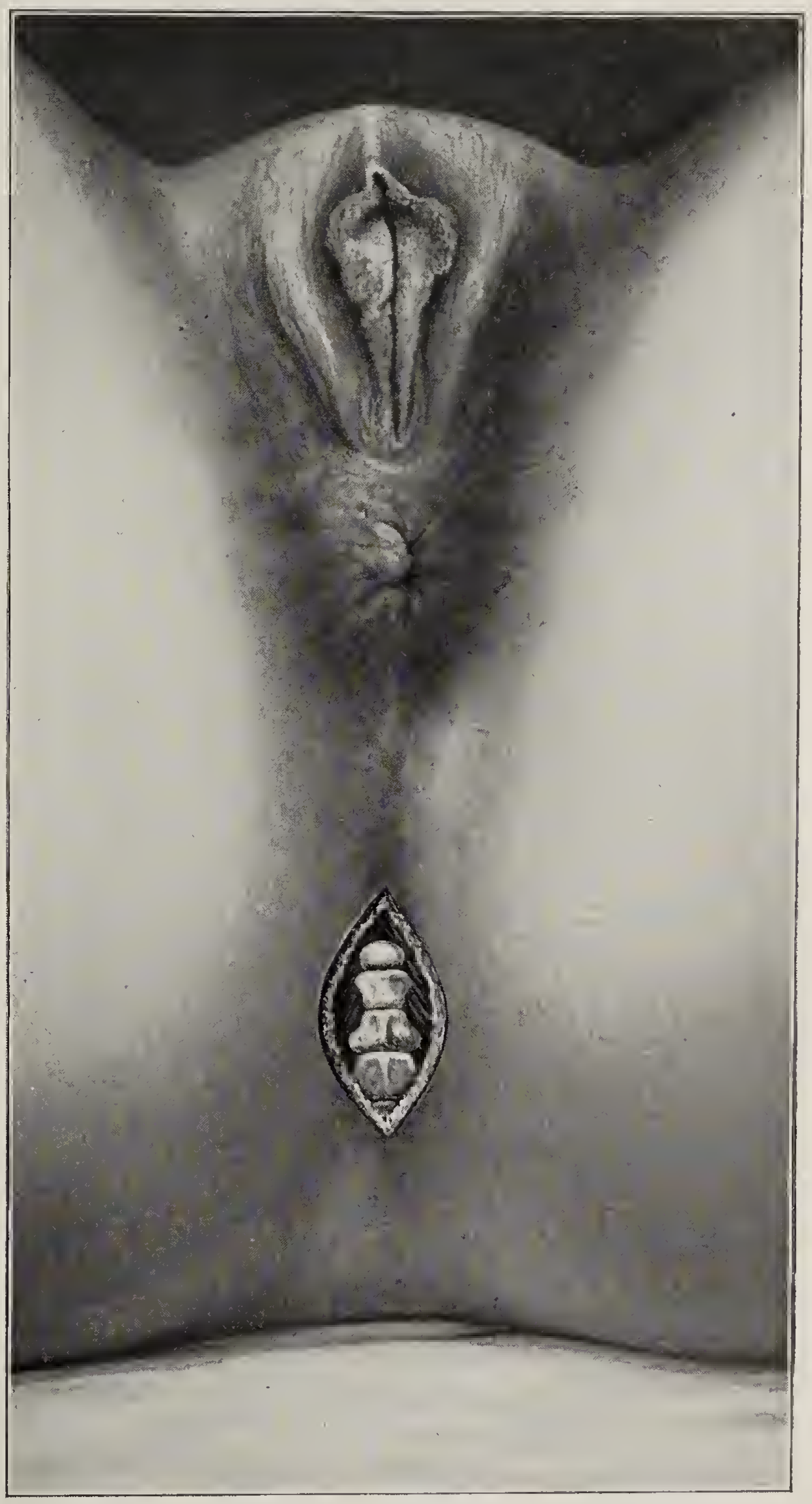

FIG. 569.—RESECTION OF THE COCCYX.
Exposure of the coccyx through a median incision.

Nontraumatic suppuration of the pelvic bones, or **caries,** is the result of either **tuberculous osteomyelitis** or **syphilitic infection.** The former is much more frequent than the latter, as well as much more difficult to deal with, for the reason that the diseased tissues cannot be removed with certainty. The patient usually dies of either disseminated tuberculosis or amyloid degeneration of the abdominal glands. The disease attacks by preference (1) the posterior medullary portion of the ilium, near the sacroiliac synchondrosis; (2) the tuberosity of the ischium. It sometimes attacks the crest of the ilium, the pubis, sacrum, and coccyx. **Gummatous nodules** may arise in any portion of the pelvic bones. **Necrosis of the pelvic bones** sometimes occurs after traumatic suppuration; more rarely as a sequel of acute osteomyelitis. Sequestra of the pubis at the symphysis sometimes invade the bladder and form the nucleus of a calculus.

Treatment.—In tuberculous caries of the pelvic bones *évidement* by means of the chisel, gouge, and sharp spoon is indicated. Complete removal of the diseased tissue is rarely accomplished, however. After as much of the diseased tissue as possible has been gouged and scraped away, the resulting cavity is to be filled with pure carbolic acid, which is allowed to remain *in situ* for one minute. The acid is then neutralized with 95 per cent alcohol, after which the cavity is packed with iodoform gauze. Syphilitic caries indicates antisyphilitic treatment. Necrotic portions of the pelvic bones are to be removed by **sequestrotomy.**

Inflammations of Muscles and Bursae Mucosae in the Pelvic Region.—Of these, the most important are **psoitis** and **psoas abscess.** The first may occur as a postpuerperal complication and lead to considerable confusion in the diagnosis. Psoas abscess has its origin most frequently in tuberculous osteomyelitis of the lower dorsal and lumbar vertebrae. Suppurative inflammation at the inner surface of the ilium may be followed by abscess, situated at first beneath the iliac muscle, afterward reaching the sheath of the psoas. Again, suppuration of the neighboring lymph-glands may lead to psoas abscess. Finally, extensive suppuration may follow **rupture of the psoas** occurring in the course of typhoid fever, infection taking place at the point of rupture.

Bursae Mucosae.—The deeper bursae mucosae, as, for instance, that extending upward from the tuberosity of the ischium and lying between the gemelli and the obturator internus muscle, as well as that covering the lower surface of the ischium, are rarely affected. A large bed-sore or ulcer from pressure may open into the latter, however, and lead to a dangerous phlegmonous inflammation of the deep connective tissue. The bursae mucosae situated between the posterior surface of the sacrum and coccyx and the skin are frequently the seat of inflammation. While these bursae appear rather irregularly at any part of the sacrum and coccyx, the most common site for them is in the median line. These become infected from the skin, in some instances after irritation and accumulation of secretion from sitting or horseback-riding. After evacuation of the abscess a fistulous track remains, with a seropurulent discharge. These **sacral** and **coccygeal fistulas** are not to be mistaken for anal fistulas. They differ from the latter in the character of the discharge, which is synovial, by their median situation, and by not opening on the perineum. The use of the probe will usually settle the question. **Congenital fistulas** are likewise frequently found in this situation. In the deep furrow sometimes seen running from the anal margin to the point of junction of the sacrum and coccyx there are sometimes found one or more fistulous openings emptying into the furrow, which can be traced upward for varying distances. These have been attributed to a cystic degeneration of the rudimentary structure, known as the **coccygeal glomerulus,** or **Luschka's gland.**. The existence of this gland has been denied by other anatomists (Arnold).

The **treatment** of inflamed and suppurating bursae mucosae is complete extirpation of all infected tissues. The same treatment is applied to sacral and coccygeal fistulas. The most rigid and persistent antiseptic treatment is required in the after-course of the case, in order to effect healing.

Malformations and Tumors of the Pelvic Region.—The most important of these is that known as **congenital sacral tumor.** These may be (1) **fibrolipomas,** these containing larger or smaller cystic structures; (2) **cystohygromas**; (3) **teratomas,** containing lime salts, cartilaginous or osseous structures, hair, and striated muscular fiber, in fact, a rudimentary fetus. Some of the larger of these tumors possess muscular movements of their own, independent of the surrounding normal muscular structures. Others are intimately connected with the normal muscular and fascial structures, as well as with the osseous structures. When the vertebral arches are separated, these tumors resemble spina bifida. Plexiform neurofibromas have also been found (P. Bruns). Tumors may also develop from the anterior surface of the sacrum.

Those connected by broad attachments to the vertebrae are not, as a rule, operable. Even those apparently quite movable are sometimes connected with the vertebral canal, and the greatest care is necessary in their removal to avoid fatal septic spinal meningitis. The mortality following these operative attempts is very high and by some surgeons the operations are considered unjustifiable. When the tumor contains large individual cysts, injections of tincture of iodin may be tried.

The malignant tumors of this region develop in all ages, but particularly after the age of childhood. They spring most frequently from the ilium. **Sarcoma,** and particularly **angiosarcoma,** is the most frequent type. They frequently contain radiating cancelli and then are somewhat harder (**osteosarcoma**). Enchondromatous structures are also sometimes found. Sarcomas in this region are sometimes sufficiently vascular to pulsate, thereby simulating an aneurism. Sarcomas of the pelvic bones are usually primary, but they may be secondary to similar growths in the thigh, as recurrences after amputation or disarticulation at the hip-joint.

Malignant growths in this region are almost without exception inoperable, as far as radical cure is concerned. Pressure on the rectum may produce obstruction and demand the formation of an artificial anus.

Large lipomas sometimes develop in the soft parts of the lesser pelvis and project either alongside of the rectum, or at the greater sciatic notch beneath the gluteal muscles. Extirpation is accomplished by exposing the growth at the point where it has escaped from the pelvis and drawing out the mass.

Ligation in Continuity of the Arteries of the Pelvis.—Hemorrhage following recent injuries and aneurism are the most frequent indications for the application of a ligature in continuity in this situation, as elsewhere. The external iliac artery has been ligated with good results in certain cases of elephantiasis. The internal iliac has been ligated preliminarily to hysterectomy and also for the relief of enlarged prostate.

Owing to the fact that endarteritis deformans attacks by preference the point of bifurcation of the common iliac into the external and internal iliacs, both fusiform and sacciform dilatations of the vessels occur here more frequently than in other parts. They may encroach on the common iliac to such an extent as to make it difficult or impossible to apply a ligature to this vessel.

Aneurism of the gluteal arteries sometimes follows injuries in the gluteal region. If small, the aneurism is to be exposed and the vessel ligated at each side of the aneurism. If the aneurism is of considerable size, ligation of the internal iliac artery is preferable. In recent injuries in the gluteal region, with profuse hemorrhage, the bleeding vessel should be secured, the wound being enlarged if necessary.

The most frequent as well as the most important of the ligations in this region is that of the external iliac artery. In former times, before the use of the aseptic ligature, the dangers of secondary hemorrhage from the impossibility of formation of a long clot in the case of the ligation of the femoral artery, owing to the short distances between its branches, and the existence of the opposite condition in the case of the external iliac, led to the selection of the latter vessel for ligation instead of the former. Ligation of this vessel is indicated in secondary hemorrhage following ligation of the femoral.

Ligation of the Aorta, Common Iliac Artery, External and Internal Iliac Arteries.—**Ligation of the aorta** is indicated by aneurism of the external and internal iliac arteries in cases in which it is not possible to apply the ligature to the common iliac on account of a diseased condition of that vessel, by aneurism of the common iliac, and by secondary hemorrhage following ligation in continuity of the common iliac artery. The operation is one of great difficulty, as well as danger, and many surgeons express a doubt as to whether it ought ever to be performed.

The aorta can be ligated only below the point where the renal arteries are given off. The ligature must be applied as low as possible, in order to favor the collateral circulation to the pelvic organs and the lower extremities. The superior mesenteric artery is of least importance in this respect, being a terminal artery, while the lumbar arteries through their anastomosis with branches of the internal iliac, the internal mammary through the terminal branches of the epigastric at the ensiform cartilage, and the communication between the inferior mesenteric and the internal pubic furnish the channels through which the circulation below the point of ligature is finally reestablished. Paralysis of the muscles of the lower extremities has frequently followed experimental ligations of this vessel in the lower animals. This has been shown by Schiffer and Weil to be due to anemia of the spinal cord rather than to the cutting off of the supply of blood to the extremities.

The abdominal cavity should be opened freely to the left of the median line, the intestines drawn to the right side, the posterior layer of the peritoneum opened by bluntly separating the root of the mesentery and the vessel thus reached (Cooper). Maas's method is designed to reach the vessel from behind, the incision being placed at the anterior edge of the quadratus lumborum. C. Hueter proposed an incision along the posterior edge of the latter muscle.

Ligation of the common iliac is performed through practically the same incision as that employed for ligation of the aorta.

Ligation of the External Iliac Artery by the Extraperitoneal Method.—Typic ligation is performed by making an incision parallel to Poupart's ligament and extending from the middle of the symphysis pubis to the anterior superior spinous process of the ilium. The artery rises from the pelvic cavity and crosses the middle of this line to become the femoral artery. After separation of the aponeurosis of the external oblique, which lies immediately beneath the skin with Poupart's ligament forming its free border, the internal oblique, with its well-marked muscular structure and fibers running at right angles to the line of incision, comes into view. These are incised the whole length of the wound. The transversalis muscle may appear in the upper portion of the incision; at the lower and inner portion it is replaced by the connective-tissue layer of the transversalis fascia. This, together with the peritoneum, is now separated from the anterior portion of the iliac fossa, and retracted upward and toward the median line by an assistant. The pulsation of the vessel is felt as it lies on the iliac muscle. The ligature must be placed a fingerbreadth or more above Poupart's ligament, in order to avoid the internal epigastric and deep circumflex arteries. The vein passes downward, and lies to the **right of the artery** on each side; the artery needle must be passed from without inward on the right side and from within outward on the left side. The circumflex iliac vein crosses the anterior surface of the artery obliquely at the point of selection for ligation; its injury may embarrass the subsequent steps of the operation. The artery needle is passed, armed with a catgut ligature of moderate size, around the vessel from the direction of the vein. The crural nerve lies at least two centimeters from the artery, on its outer side; the ilioinguinal nerve lies somewhat nearer.

The Transperitoneal Method.—An incision is made along the outer edge of the corresponding rectus abdominis muscle and through the peritoneum. The patient is placed in the elevated pelvis position of Trendelenburg (see page 365) and the vessel identified. The posterior layer of the peritoneum is opened directly over the artery by carefully tearing it with two pairs of dissecting forceps and the artery needle passed from the direction of the vein.

Unless some abnormal condition of the extremity prevents, the **collateral circulation** is quickly established. The obturator branch of the internal iliac communicates with the profunda; the circumflex iliac forms a communication between the femoral and the iliolumbar branch of the internal iliac. The gluteals assist by their communication with the external circumflex from the profunda. A small branch is given off from the inferior gluteal and accompanies the sciatic nerve; this anastomoses with the network of vessels about the knee-joint. The temperature of the limb, lowered at first, soon becomes normal. The entire extremity should be wrapped in cotton and lightly bandaged with a flannel roller.

Ligation of the Gluteal Arteries.—This operation is not easy of performance, on account of the necessity of reaching the artery through the thick gluteal muscles. It should be performed whenever practicable in preference to ligation of the internal iliac. An incision five inches long is made from the posterior superior spine of the ilium to the great trochanter. The superior gluteal lies at the upper edge of the pyriformis, the inferior at the lower edge of this muscle.

Ligation of the Internal Iliac Artery.—A cutaneous incision is made, passing from the apex of the last rib vertically downward until the crest of the ilium is reached; from this point the incision is carried along the crest until the anterior superior spine of the ilium is reached. This incision is carried through the transversalis fascia. When the peritoneum is reached, this is separated from the iliac fascia and displaced toward the median line. The external iliac artery is identified between the iliac fascia and the psoas muscle and is followed in an upward direction to the internal iliac. The vein lies to the inner side.

Transperitoneal Ligation of the Iliac Arteries.—By far the best method for ligating the iliac arteries is through an abdominal incision. The common, the external and the internal iliacs can be easily reached through an intermuscular incision on the corresponding side, similar to that employed in the operation for appendicitis, or through a median incision. The patient is placed in the Trendelenburg position and the abdomen opened on the corresponding side. The median incision is always employed when both internal iliacs are to be tied, as, for instance, as a preliminary procedure in abdominal hysterectomy (Munde, Pryor). The overlying peritoneum is opened and the vessel identified and secured.

THE SCROTUM

Wounds.—**Contusion** is the most common form of injury of the scrotum. This may result from horseback-riding or bicycle-riding, blows, kicks, etc. Extravasation of blood and extensive ecchymosis result.

Incised wounds are almost exclusively confined to those self-inflicted by certain insane persons.

Lacerated wounds result from falls on the perineum, as well as from bayonet thrusts and gunshot injuries. When deep, the testicle may be exposed; in gunshot injuries the latter organ is generally injured at the same time.

Punctured wounds from falls on nails, among farmers from the prongs of a pitchfork, and in children from splinters contracted in sliding on rough planks or boards, are occasionally met with. These wounds are specially prone to infection, particularly to that of erysipelas.

In **operation wounds** where bleeding vessels are not properly secured, free hemorrhage into the loose connective tissue of the scrotum and spaces in the dartos takes place.

Treatment.—In contusions an evaporating lotion and elevation of the parts are all that are required. In lacerated and contused wounds the parts are to be brought together after thorough cleansing, so as to cover the exposed testicle as much as possible, and antiseptic dressings applied. **Fungus of the testicle** occasionally follows these injuries. This is to be treated by cauterization and dry dressings. In punctured wounds search should be made for foreign bodies, the parts cleansed and antiseptic dressings applied. Suture should not be employed, and free incisions should be practised if septic conditions supervene.

Abscesses of the scrotum usually follow infection, with or without an open wound. Tuberculous processes extending from the testicle also cause them. **Furuncles** result from infection along the hair-follicles. They are to be incised freely.

Tumors of the Scrotum.—**Atheromas** are the most frequently observed. **Dermoid** tumors of both scrotum and testicle, resembling those found in the ovary, also occur, though rarely. **Condylomas** are syphilitic manifestations and are best treated with the red oxid of mercury ointment. **Elephantiasis of the scrotum** is almost exclusively met with in the tropics; the pendulous mass sometimes reaches to the ground. In operations on these the testicles should be preserved; they become covered eventually by cicatricial tissue.

Myomas of the dartos and **lipomas** of the scrotum have also been observed.

Carcinoma of the scrotum, or chimney-sweeper's cancer, so called from its greater prevalence among those who are brought into contact with soot, appears in the shape of warty growths, which, in a certain proportion of cases, finally ulcerate, the ulceration extending to form an epitheliomatous ulcer of the skin and finally involving the whole scrotum. The tunica vaginalis testis is occasionally involved in the disease. An ulcerative condition of the scrotum simulating this disease is said to arise from contact with tar and paraffin (Butlin).

The inguinal glands are infected and the skin over the glands involved, leading to extensive ulceration and deep destruction; fatal hemorrhage sometimes occurs from opening the external iliac or femoral artery. All of these conditions may be anticipated and a cure brought about by early and careful removal of the entire diseased area, while it is still in the wartlike stage. Recurrence is rare after early and complete removal. Extension to the testicle is unusual.

THE TESTICLES

Contusions of the testicles from riding accidents, the parts coming in violent contact with the saddle, as well as from kicks and blows and from falling astride rigid objects, are comparatively common but rarely serious. With these exceptions, the organ when normally situated is not liable to injury. The symptoms are a peculiar dull, sickening pain, and faintness. In severe contusions hematocele may result or a violent orchitis supervene. Finally, hydrocele, or fibroid changes the result of chronic inflammation, may ensue as a remote consequence of the contusion.

Wounds of the testicle may be incised or punctured (stab and bayonet wounds), or lacerated, as in case of the goring of a vicious animal. **Gunshot wounds** are occasionally met with. The surgeon should not be too hasty in performing castration under these circumstances, for, unless sloughing of the organ sets in, the operation will be rarely required.

Hematocele of the tunica vaginalis is almost always due to an injury and not infrequently results from the wounding of a vessel during the operation of tapping a hydrocele. It sometimes occurs in a hydrocele from a diseased condition of the walls of the blood-vessels, the hemorrhagic diathesis, etc. **Hematocele of the spermatic cord** from direct violence or from the lifting of a heavy weight occurs, though rarely, and may be mistaken for a hernia. It may likewise take place in connection with an encysted hydrocele of the cord. In recent hematocele of the tunica an opaque tumor, resistant to the feel, is present. Later on, both the tunica and the scrotum are involved in inflammatory thickening. The affection may terminate in abscess. In hematocele of the cord the blood is effused into the tissues of the cord. There is a fusiform swelling in the groin which may be masked by swelling of the surrounding parts in cases caused by direct injury. Cases of large effusion or septic infection in hematocele require free incision and thorough cleansing and drainage of the cavity. Where the effusion is small and the case not of long standing, rest in bed and elevation of the parts, with restricted diet and free purgation, are indicated.

Inflammation of the Testicle (Orchitis).—**Acute orchitis,** pure and simple, is not of frequent occurrence. Usually the epididymis (**epididymo-orchitis**) and the tunica vaginalis take part in the inflammation. It may result from traumatism, or it may be the extension of disease of the bladder, the urethra, and the vas deferens (**gonorrheal orchitis**). **Orchitis-epididymitis par effort** (English) is a variety of the disease which is said to result from compression of the organ against the outer inguinal ring by powerful contraction of the cremasteric muscle. Inflammatory conditions of the deep urethra, the result of instrumentation, may lead to orchitis. Obstruction to the ejaculation of semen during sexual intercourse by compression of the urethra, straining at stool, heavy lifting, and repeated and prolonged ungratified sexual excitement are also said to be causes. Gout and rheumatism are only possible etiologic factors. So-called **metastatic orchitis** occurs most frequently as a complication in parotitis or mumps or as a sequel of this disease; it may precede the inflammation of the parotid gland and may occur during epidemics of mumps in patients in whom no trace of parotitis can be found. Acute orchitis also occurs in connection with diseases due to morbific elements in the blood, such as pyemia, variola, scarlatina, typhus and typhoid. Finally, a variety of orchitis accompanied by abscess and followed in some instances by fungus testis from causes not demonstrable occurs in little children.

The **symptoms** of orchitis vary from those which accompany the mild hematogenic forms of the disease to the higher grade of inflammation in gonorrheal cases and the rapidly supervening suppurative conditions which characterize staphylococcus and streptococcus infection from urethral and bladder instrumentation. The enlargement is not great, except in cases accompanied by epididymitis, the rigid tunica albuginea limiting the swelling, nor is the shape changed. A sense of tension and pseudofluctuation are found on palpation. The pain is much more acute later on than in the beginning and the sensitiveness also progressively increases. These symptoms, together with the supervention of febrile disturbances and nausea and vomiting, in severe cases, occurring in connection with the inguinal or crural variety of ectopic testicle may simulate the symptoms of strangulated hernia. After a few days the pain and other acute symptoms subside, until only slight tenderness remains. In case abscess follows, the cavity of the latter may fill with granulation tissue; or in case the intertubular tissues are invaded, the tubules lose their support, and, protruding as a brownish mass through the abscess cavity together with the exuberant granulations, form what is known as **fungus testis.** Sinuses leading to centrally located septic foci may persist. Finally, multiple abscesses or successive suppurative invasions may occur, or some portion of the interior of the gland may be the seat of an abscess which does not tend to point externally and the contents of which may calcify; or sloughing of the organ may follow pressure due to the accumulation.

The **prognosis,** as far as danger to life is concerned, is favorable. The most important complications and sequels relate to the occurrence of **atrophy of the testicle,** which is comparable with the connective-tissue contraction of the kidney following nephritis, and the results of suppurative changes. True **gangrene** of the organ is rare, except as the result of crush injuries. Life may be threatened by septic infection passing along the spermatic cord and producing pelvic cellulitis or peritonitis.

Chronic orchitis may follow the acute form of the disease through the formation of abscesses and consequent induration. A form of orchitis is described which is chronic from the commencement and which may be either diffused or circumscribed. In the diffused form the organ becomes considerably enlarged, this enlargement being accompanied by cyst formation. In the circumscribed variety abscesses occur. The epididymis is rarely involved. Hydrocele may be present. The causes are repeated attacks of gonorrhea, chronic non-specific urethritis, and severe strain following gonorrhea (Kocher).

In the treatment of acute orchitis, with or without an accompanying inflammation of the tunica vaginalis or **periorchitis,** and **epididymitis,** rest in bed with the testicles supported on a pillow or slung up on the abdomen is to be insisted on. In some cases the acute symptoms are rapidly relieved by the application of compresses wrung out of ice-water or by the use of the ice-bag. In others, lead and opium lotion, or poultices of flaxseed and fine-cut tobacco (in the proportion of one part of the latter to three of the former), changed every two or three hours, are more acceptable to the patient. These measures, together with sufficient morphin, administered either hypodermically, per rectum, or by mouth, to control pain, and the use of saline cathartics, constitute the usual treatment. As the inflammation subsides the Paquelin cautery is to be applied every two or three days to the scrotum over the swelled testicle. Abscesses should be opened and treated antiseptically. The brownish mass forming a fungus testis should not be mistaken for a slough and removed. By the persistent use of such stimulating applications as balsam of Peru, naphthalin, camphor naphthol, etc., the abscess cavity can usually be closed and the fungus covered in, the organ being thus preserved. If these fail, a dressing wet with a nitrate of silver solution and compression should be tried (Curling). If the fungus still persists, the skin at the edge of the fungus should be loosened, its edges freshened, and, after relaxation incisions at each side of the flap are made, the skin should be united over the tumor (Syme). Sinuses should be freely opened up, curetted, and induced to heal from the bottom. Strapping the testicle for the purpose of removing the inflammatory products is not so frequently resorted to as formerly. Compression may be efficiently applied by Chetwood's bandage (Fig. 570). A well-fitted suspensory bandage should be worn by the patient as soon as he is up. In chronic orchitis, if the cause lies in the urethra, this should be treated. The testicle should be supported by a padded suspensory bandage. In the circumscribed form the organ should be incised and treated antiseptically. In the diffused form, and in the circumscribed also when the organ has become practically useless from connective-tissue growth, castration is the only resource.

Epididymitis arises from the same causes which produce orchitis, *i. e.*, injury, the extension of disease from the urethral mucous membrane, infection through the blood from pyemia, scarlatina, typhus and typhoid. The affection may be acute, subacute, or chronic; it may involve both testicles, either simultaneously or successively, particularly if it arises from a chronic urethral affection. There may be a special predisposition to its repeated occurrence.

In both the traumatic and the gonorrheal form, pain in the groin is, as a rule, the initial symptom. This is followed by a dull, aching pain referred to the testicle and extending along the cord and into the lumbar region. There may be irritability of the bladder (Curling). Sudden acute pain in the testicle may be the first symptom. All of the symptoms may be preceded by a diminution of the discharge, in urethral cases; the latter may not reappear. Moderate fever, which subsides before the patient is free from the other symptoms of the disease, is the rule. Sensitiveness of the part is exquisite, and palpation shows considerable increase in size of the organ, which commences as a hard lump at either the globus major or the globus minor. Inflammatory edema of the scrotum at the site of the epididymitis is observed. There may be some effusion in the cavity of the tunica vaginalis, or simple adhesive periorchitis may occur. The structures of the cord, including the vas deferens, may become involved (**deferentitis**). In the event of considerable effusion and scrotal involvement

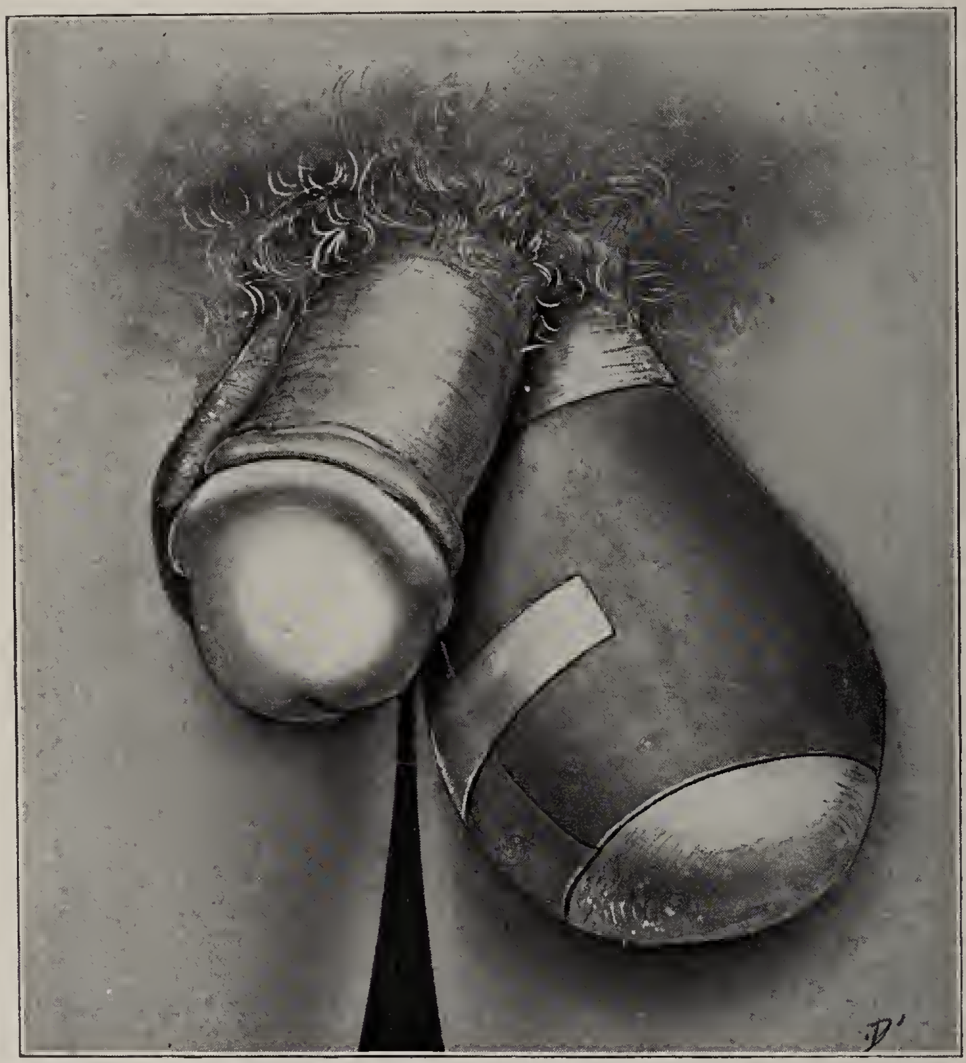

FIG. 570.—CHETWOOD'S COMPRESSION BANDAGE FOR EPIDIDYMITIS IN THE SUBSIDING STAGE. The diseased organ is isolated with its scrotal coverings and enveloped with a piece of thin rubber dam, fitted to the parts by stretching. This is held in place by strips of adhesive plaster.

in the inflammation, there are no means of determining whether or not the inflammation has gone over to the testis proper, except possibly by an increase in the severity of the symptoms.

The disease reaches its height in from two to five days; its subsidence depends on the severity of the attack. The swelling may remain a considerable time after the acute symptoms have passed off. Tenderness, however, may continue after the induration has disappeared entirely. Cheesy degeneration (the so-called "gonorrheal tubercle") may follow encysted suppurative products. Acute abscesses are rare. Hyperacute cases may simulate peritonitis. In subacute cases the patient suffers but little pain and only a portion of the epididymis may be involved. Varicocele, if present, will be aggravated by fusion with the epididymis.

The **treatment** consists in the application of the same measures of treatment as in orchitis. The patient should not be permitted to resume the erect position until the parts have been properly strapped or a suspensory bandage applied as follows: The entire scrotum is enveloped in a thick layer of non-absorbent cotton and over this is placed a piece of gutta-percha tissue or oiled silk. A suspensory bandage of linen is now applied in such a manner as to lift the testicles against the front of the pubis. The cord is relieved of all weight and the parts are subjected to firm, soft compression. The bandage is to be worn day and night, the cotton being renewed daily. In order to hasten absorption of the induration later on, a thin layer of absorbent cotton or lint, saturated with glycerin with the addition of tincture of iodin in the proportion of a dram to the ounce, may be applied under the bandage (Burnett).

All treatment of the urethritis should be held in abeyance until the subsidence of the epididymitis.

In **chronic epididymitis** there is a connective-tissue proliferation, the clinical appearances comprising increase in size, with induration of the organ. On section, in addition to the condensed connective tissue, remains of the epididymal canals and yellowish granular collections representing fatty degenerated epithelium are found. The disease follows an acute attack. Acute or subacute relapses occur. Periorchitis, with or without effusion, accompanies it. The **treatment** consists of removal of exciting causes, when possible, and abstention from coitus. When only a portion of the organ is diseased, incision and removal of the diseased portions may suffice. Otherwise, castration may be resorted to.

Syphilitic epididymitis usually occurs in the early part of the secondary period of the disease, this varying from the second to the seventh month. It may occur in the tertiary period and has been observed as late as the twelfth year. The globus major is most commonly the seat of the disease at the commencement, the entire organ becoming subsequently affected. Both organs may be attacked simultaneously. There is little or no pain. Antisyphilitic treatment is followed by recovery.

Syphilitic orchitis (sarcocele) occurs as either a diffused or a circumscribed gummy infiltration. It attacks the testicle usually in the interval between the second and the fourth year of the disease. It may occur as early as the fourteenth week (Nélaton) and has been observed as late as the twentieth year (Jonathan Hutchinson). In the diffused form the stroma of the testicle is the seat of the infiltration. In the slowly developing and painless enlargement which follows and sometimes attains the size of a large fist, the normal shape and contour of the organ are maintained. There is no special tendency to suppurative changes in this form. In the circumscribed variety isolated gummatous nodules are scattered more or less throughout the organ; the more superficially placed of these become agglutinated to the investments of the testicle. The latter become involved in the infiltration and by pressure become softened, and, together with the skin, finally break down, giving exit to detritus, flocculent material, and pus mingled with a gummy fluid. Hydrocele may coexist.

In the **differential diagnosis** syphilitic testicle is to be distinguished from gonorrheal epididymitis by its almost painless course. The history of a previously existing chancre and an insidious attack on the one hand, and of a urethral discharge and an acute onset on the other, will be of service in the differentiation. Primary tuberculosis of the testicle attacks, as a rule, the globus minor, has a more rapid course, is accompanied by more pain, and terminates more frequently in suppuration or caseous degeneration. While tenderness is almost absent in syphilitic testicle, in tuberculous testicle the organ is more than usually sensitive to pressure. Finally, the result of treatment constitutes the crucial test; while syphilitic testicle recovers under proper antisyphilitic treatment, tuberculosis of the organ is not affected by any treatment short of extirpation. Hydrocele with thick walls may be mistaken for syphilitic testicle. Malignant neoplasms grow much more rapidly, are generally limited to the testicle proper, and are accompanied by pain.

Under antisyphilitic treatment the **prognosis,** as regards both the disappearance of the infiltration and the restoration of function, is good, even where both organs have been involved. The **treatment,** consisting in the use of the iodids and mercury, should be carried on for a considerable time after apparent recovery, and relapse should be carefully guarded against. Ulceration is treated by antiseptic and protective applications. A suspensory bandage should be worn. Operative measures are very rarely demanded.

Tuberculosis of the Epididymis and Testicle.—The testicle itself is rarely the seat of primary tuberculosis, the epididymis becoming first infected, the disease extending thence to the testicle. In fact, the epididymis is the starting-point of urogenital tuberculosis in more than half of the cases. This is due partly to the fact that the epididymis is more frequently the seat of acute inflammatory processes than the testicle, which condition establishes the *locus minoris resistentiae,* and partly because, in cases in which the infection descends from the upper urinary tract, it reaches the epididymis first. Tuberculosis of the epididymis may originate primarily in the organ itself.

The **predisposing causes** are inherited tuberculous susceptibility, existing or previous inflammatory conditions of the organ, and injury. The disease occurs most frequently between the ages of twenty and thirty, though it may occur in children (Lannelongue), in which case it is usually associated with some other tuberculous process; it is liable to be associated particularly with tuberculous peritonitis.

The disease may be present in both organs at the same time, though simultaneous invasion has not heretofore been observed. The tendency to local or to general dissemination is not great. Coexisting disease of the lung is absent in from one-third to one-half of all the cases. The tuberculous infection is said to assume an increased virulence in the presence of a gonorrheal epididymitis (Birch-Hirschfeld).

The disease almost always occurs in the caseous form. The cut section of the organ on removal shows the usual retrograde metamorphoses of the tuberculous process, such as coagulation necrosis, caseation, broken-down tissue, liquefied caseous material, and the breaking down and conversion into abscess cavities of isolated tuberculous nodules. The epididymis is rarely affected alone and tuberculosis of the testicle without the presence of a similar affection of the epididymis is still more rare. The vas deferens is affected for varying distances along its course.

Symptoms.—The disease is insidious in its development and hence is often overlooked. Exceptionally, however, the rapid development of swelling, with early softening, and the absence of pain and tenderness may characterize the onset of the disease. A slight urethral discharge frequently precedes or accompanies it. The patient's attention is often first attracted by the presence of a complicating hydrocele. In the majority of cases the disease commences in the globus major; the body and the globus minor next become invaded, the infection finally extending along the vas deferens. The swelling is hard and nodular and is formed by the coalescence of a number of small foci of infection. In the course of time one of the nodular prominences increases in size. This increase is coincident with caseation of the tuberculous focus and finally with abscess formation, and is accompanied by pain and tenderness. The overlying skin becomes involved, ulceration takes place, and the softened cheesy material escapes, a fistulous opening which leads to the tuberculous focus resulting. All the foci may undergo similar changes in succession, with entire elimination of the tuberculous material, spontaneous cure with atrophy of the testicle resulting. The vas deferens is usually affected and more or less **periorchitis (vaginalitis)** is present. Invasion of the former is accompanied by slight tenderness and a nodular feel of the cord; in the case of involvement of the tunica vaginalis a **circumscribed hydrocele** is present. The seminal vesicles, the lateral lobes of the prostate, and finally the bladder, ureter, and kidney become involved in turn. The disease may remain limited to one testicle for months or even years and finally make its appearance in the opposite organ.

Diagnosis.—Insidiousness, chronicity, the absence of subjective symptoms until the hard nodular mass undergoes caseation, abscess formation, ulceration of the overlying skin with discharge of cheesy material, are the characteristic features of the disease in the vast majority of cases. In the exceptional cases of acute onset, the marked pain and tenderness of gonorrheal epididymitis will be absent. The average case may easily simulate syphilitic testicle. It may usually be differentiated by the presence of small nodules, ranging in size from a small shot to a pea, instead of the uniform and smooth swelling which involves the testicle and epididymis alike in syphilitic orchitis. In those cases of the latter in which isolated gummatous deposits are present in the organ, the differentiation is more difficult. The effects of treatment may settle the question in case of doubt. The two diseases may coexist. The tuberculin test may be of value in the diagnosis. The prostate, bladder, and kidneys, as well as the lungs, should be examined for evidences of tuberculosis.

Treatment.—In cases of uncomplicated unilateral tuberculosis of the epididymis and testicle castration should be performed. The implication of both organs places the case beyond the reach of successful surgical intervention, as a rule, for the reason that either a tuberculous process exists in some distant organ, or the second testicle has become infected through the vasa deferentia, the lateral lobes of the prostate also becoming infected *en route*. Exceptions to this rule occur occasionally in cases in which a thorough scraping away of the tuberculous material both from the epididymis and from the testicles by free incision, and from the seminal vesicles by perineal section, this being followed by iodoform gauze tamponade, has resulted in cure. Or simultaneous double castration and évidement of the seminal vesicles, followed by the application of a 25 per cent solution of chlorid of zinc, may be performed. Senn speaks highly of the injection of iodoform glycerin emulsion in the early stages of tuberculous epididymitis. The epididymis is penetrated from end to end with a small trocar and the emulsion injected as the instrument is withdrawn. The benefit derived from this treatment is probably due more to the increased tissue proliferation following the use of the iodoform than to any antituberculous action of the latter. It corresponds to the sclerogenous process initiated by the parenchymatous injection of 10 per cent chlorid of zinc solution around the tuberculous infiltration (Lannelongue).

In cases of diffuse miliary tuberculosis, the disease affecting the testicle and epididymis will be of the same type. The hopelessness of these cases is apparent.

Hydrocele.—The term hydrocele is used to denote an accumulation of the natural secretion of the serous sac of the testicle. It may be properly applied to an accumulation in any part of the vaginal process of the peritoneum. In congenital hydrocele the sac frequently communicates with the peritoneal cavity, the vaginal process remaining open (**hydrocele communicans**). While the usual form of effusion into the tunica vaginalis is really an **encapsulated hydrocele of the testicle,** it is to this variety when of a chronic character that the term hydrocele is commonly applied.

Acute hydrocele (symptomatic hydrocele) is a concomitant of all acute inflammatory conditions of the epididymis, whether the result of injury or of disease, and in many cases of inflammatory conditions of the testicle as well, bacterial infection playing an important part in the causation. The serous sac passes through the stages of inflammation which characterize serous membranes in general, viz., hyperemia and exudation; later on these result either in new-formed connective tissue (adhesive inflammation) or in suppuration.

The **symptoms** develop suddenly and consist of pain over the site of the testicle and along the cord, and tenderness, most marked at the tail of the epididymis. The scrotal tissues may be edematous and the skin reddened. A pear-shaped, fluctuating, and tense swelling is present. If suppuration supervenes, fever, with increased pain and pointing of an abscess, occurs. In more favorable cases the effusion is gradually absorbed, and in adhesive inflammation thickening of the walls and obliteration of the sac may occur. Finally, the hydrocele may become chronic.

The **treatment** of acute hydrocele is usually limited to measures directed to the epididymitis or orchitis, of which it is a concomitant. Mild uncomplicated cases require no treatment, as a rule, beyond rest during the febrile stage and the application of cold and compression. In more severe cases, general depletion by means of salines, and the application of ice may be employed. Aspiration is rarely necessary. Cases which go on to suppuration should be incised early, under cocain anesthesia, and an antiseptic regimen instituted. A suspensory bandage should be worn for some time afterward.

Chronic hydrocele (idiopathic hydrocele) is the condition to which the term hydrocele is commonly applied. Except in cases of traumatic origin and in those in which the disease follows an acute inflammatory condition of the tunica vaginalis, the causation is obscure beyond the fact that there exists a discrepancy between the amount of serous fluid secreted and that resorbed. While in some isolated instances a genuine inflammatory condition may be demonstrated (chronic periorchitis), in the great majority of cases pathologists have failed to find any inflammatory condition present, as this term is usually applied (Virchow, Klebs). In exceptional cases of decidedly inflammatory origin, while the tumor may be large, but a small quantity of fluid, or none at all, may be present. The bulk of the enlargement consists of a greatly thickened tunica (**periorchitis prolifera**), the inner surface of which is irregular, with perhaps excrescences similar to synovial villi; the latter may finally undergo calcareous degeneration. This variety may be mistaken for malignant disease, or an enchondroma. A hemorrhagic form of periorchitis has been described (**chronic hematocele**).

The **symptoms** in cases chronic from the commencement, are insidious in their development. There may be a sense of weight or dragging sensations in the cord. Pain is not usually complained of. The patient's attention is generally first attracted by the enlargement, the development of which usually takes place from above downward. The enlargement is pear-shaped and fluctuates in cases of recent development; the testicle is found to be behind the accumulation of fluid, at which point the consistency of the tumor is harder than elsewhere. Exceptionally the testicle may lie in front (congenital inversion of the testicle). The enlargement is limited to the inguinal canal and the parts below, the spermatic cord being easily felt above the tumor. Posture does not affect the aspect of the tumor except in cases of communicating hydrocele. In large hydroceles tension on the surrounding skin produces attenuation of the latter and may cause the penis to appear shorter or even to disappear altogether. Tension on the skin in elderly persons may lead to gangrene.

Diagnosis.—The translucency test is generally applicable, though not invariably trustworthy (in case of periorchitis prolifera). A lighted candle is held on the further side of the scrotal tumor while the observer places a tube about the diameter of the finger against the surface so as to prevent all light from passing through the tube to the eye of the surgeon except that which passes through the hydrocele fluid itself. In the case of a solid tumor no light will be transmitted.

The **differential diagnosis** includes exclusion of hernia, epididymitis, cystic tumors, hematocele, and abscess. In cases of proliferating periorchitis, solid tumors and malignant disease are to be excluded. In doubtful cases aspiration may be employed.

The **prognosis** in hydrocele is favorable in uncomplicated cases. Proliferating hydrocele, however, may produce pressure atrophy of the testicle. In suppurating cases the patient is subject to the same dangers as in suppuration elsewhere.

Treatment.—Operative interference is the only treatment applicable. The object to be attained, namely, that of partial or complete obliteration of the sac of the tunica vaginalis by producing adhesion of its walls, is best reached by tapping the sac, evacuating its contents, and injecting pure carbolic acid into it (Levis). The proposed site of tapping, which should always be in front, is first anesthetized by a hypodermic injection of a 4 per cent solution of cocain or by freezing with chlorid of ethyl. The needle of a hypodermic syringe is first introduced until the fluid flows. This needle is left *in situ*. The hydrocele is now grasped behind with the left hand, the fluid contents forced forward and the trocar introduced by a slight boring motion. The point of the index-finger of the hand grasping the instrument is placed firmly against the trocar at about an inch from its point, in order to prevent the latter from entering the cavity too suddenly and injuring the testicle (Fig. 571). As a further precaution against the latter accident the point should be depressed as it enters the cavity. Or, the ordinary aspirator may be employed. When the sac is emptied, 20 to 100 minims, according to the size of the hydrocele, of a 95 per cent solution (the pure liquid carbolic acid of the shops) is introduced through the previously inserted hypodermic needle. The cannula is now withdrawn and the sac manipulated so as to distribute the carbolic acid evenly about the interior. Some swelling follows, which subsides in the course of a week or ten days, during which a suspensory bandage, padded with cotton, is worn. It is not usually necessary to confine the patient to the house after twenty-four hours. Should excessive reaction occur with evidences of tension from the presence of fluid in the tunica vaginalis, secondary aspiration should be performed and the patient kept in bed for a few days with the testicles supported. A permanent cure is usually effected at one sitting. Exception-

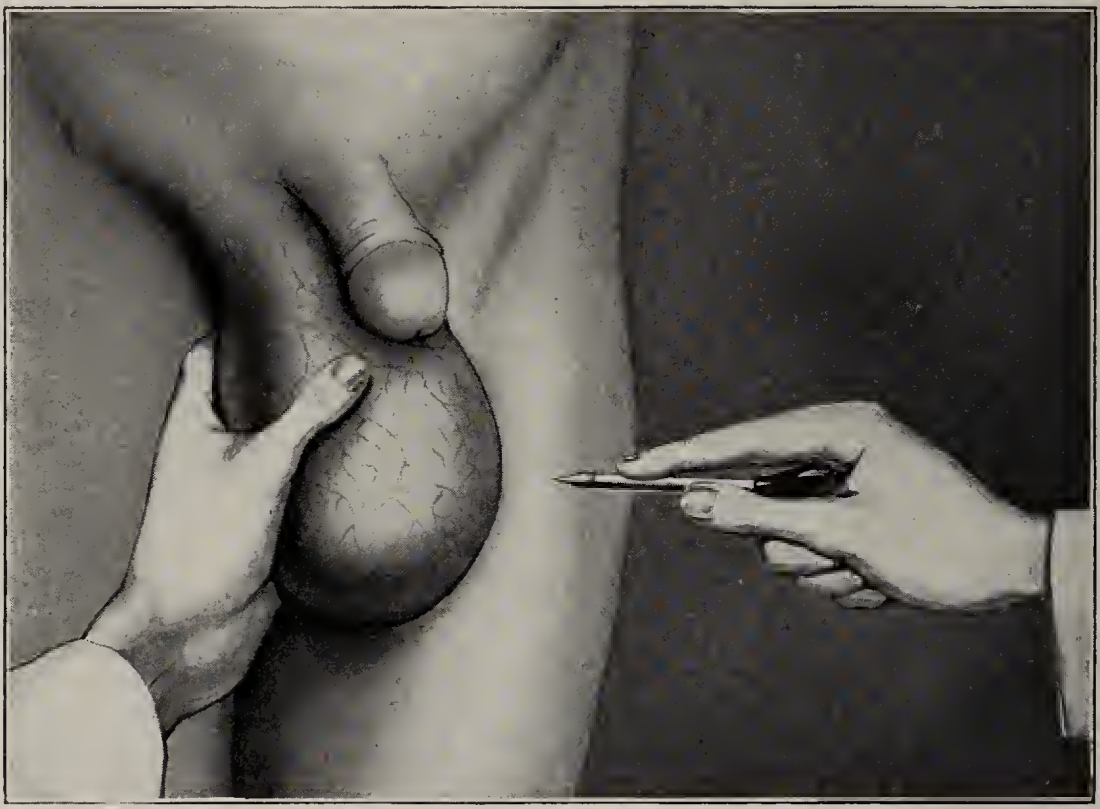

Fig. 571.—Tapping a Hydrocele.

ally, a recurrence may take place, when a larger amount of carbolic acid should be used.

In case of failure by Levis's method, and this will occur only when the sac walls are greatly thickened, **Volkmann's operation** is sometimes resorted to. This consists in making a three or four inch longitudinal incision through the skin and tunica, and stitching, with catgut, the edge of the parietal layer of the tunica to the wound in the skin. Sublimate irrigation is practised and the sac is tamponed with sterile or iodoform gauze. The parts are dressed aseptically, the dressings are changed after several days, when the gauze is permanently removed. The objections to this operation are, first, the difficulties in keeping the parts aseptic without confining the patient to bed for a period of two weeks or more, and, second, the careful after-treatment and elaborate dressings necessary.

Eversion of the Tunica Vaginalis for the Radical Cure of Hydrocele (Longuet).—The technic here described differs somewhat from that of Longuet, though the same end is reached. The scrotum is grasped in the operator's left hand and rendered tense. The point of a curved bistoury is entered in the upper third of the scrotum and about half-way between the raphe and the outer lateral border. When its point has just reached the cavity of the tunica vaginalis, as shown by the exit of the fluid, it is made to emerge from one to two inches lower down according to the size of the hydrocele. The tissues between are incised by a single upward cut (Fig. 572). Or, the cavity of the tunica vaginalis may be reached by dissection. The testicle is forced out at once through the incision, together with the tunica vaginalis, which is then everted. The inner edge of the incision is grasped by two hemostatic forceps (Fig. 573) and a pocket for the reception of the testicle is made beneath the skin of the scrotum by bluntly dissecting up the latter in the direction of the raphe. After the testicle is placed in its new position by being rotated inward about a quarter of a turn on its own axis, the outer incised edge of the tunica vaginalis is sutured with three or four chromicized catgut sutures applied to the inner or raw surface of the inner lip of the skin incision about a quarter of an inch from the free border of the latter (Fig. 574). These sutures do not pass through the skin. The skin incision, which is considerably diminished in size, owing to the evacuation of the

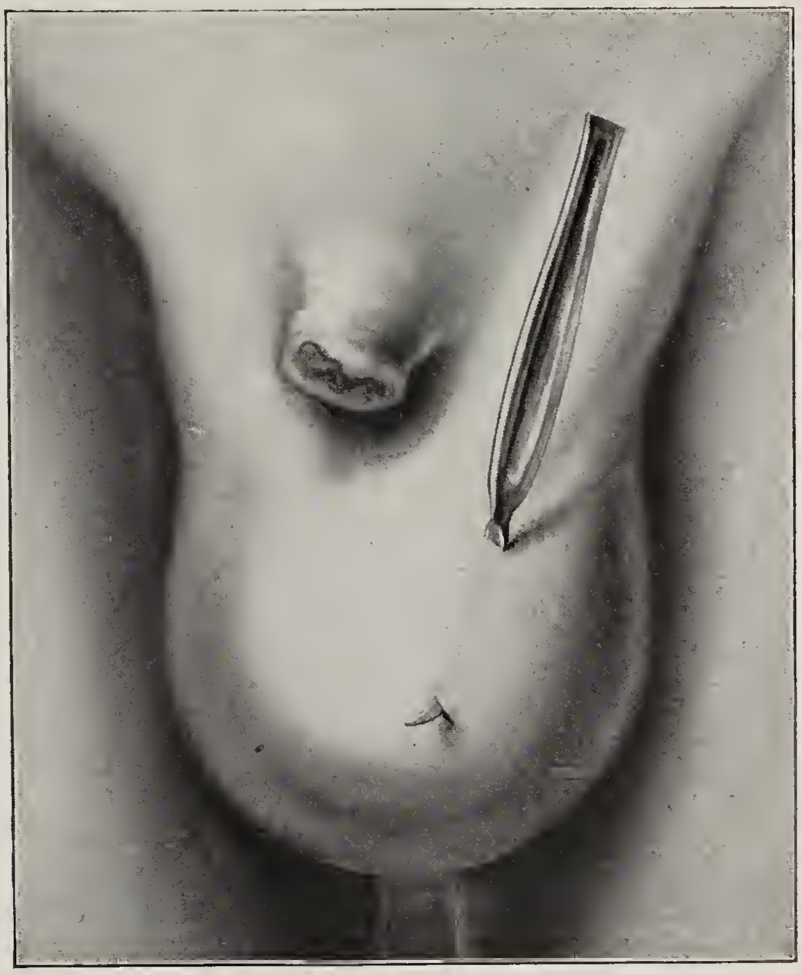

FIG. 572.—OPERATION FOR HYDROCELE.

One of the methods of making the incision. This method may be employed in cases that have been tapped on former occasions. In cases that have not been treated by former tappings the sac of the hydrocele should be exposed before opening it by dividing the superimposed structures layer by layer.

hydrocele, is now closed. The operation may be performed under cocaine anesthesia.

Failure to cure by either of the above methods will necessitate the operation of excision of the parietal layer of the sac by means of the curved scissors, through a longitudinal incision made the entire length of the tumor.

The treatment of **communicating hydrocele** of the newborn is limited to judicious compression during the first few days after birth, and, this failing, to aseptic aspiration with a fine needle and the subsequent application of compression of the neck of the sac by either a truss or a graduated compress and spica bandage. Under no circumstances should irritating injections be employed.

Free bodies in the tunica vaginalis are sometimes found in connection with hydrocele and are similar to the floating cartilages found in synovial sacs of joints.

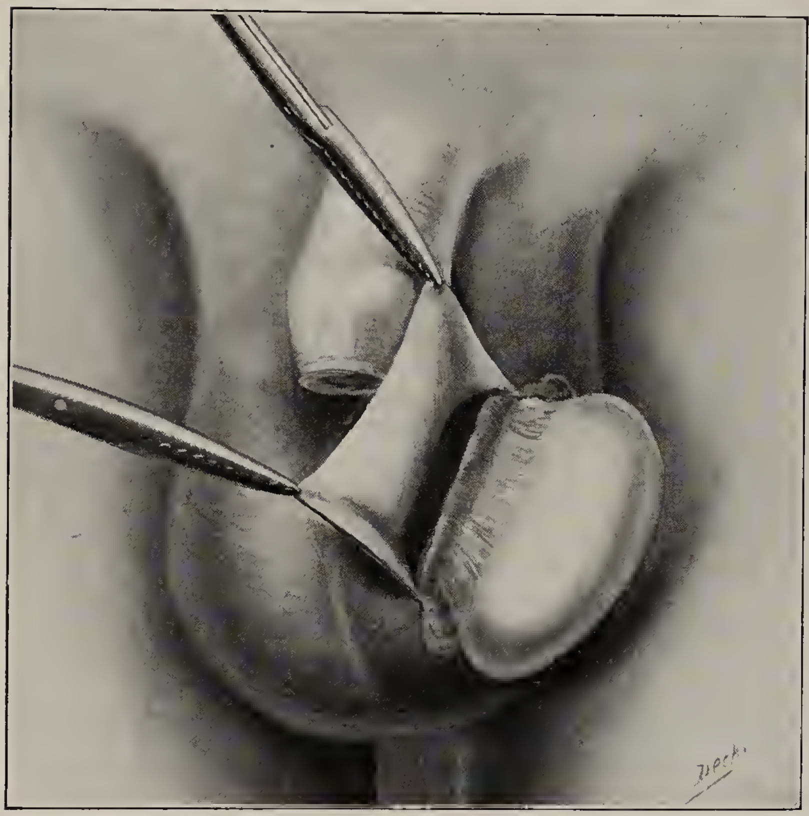

Fig. 573.—Operation for Hydrocele.

The testicle is shown turned entirely outside of the tunica vaginalis by inverting the latter. A pocket has been formed beneath the skin of the scrotum by blunt dissection, into which the testicle is to be lodged. The forceps are shown grasping the skin at the inner margin of the wound in order to facilitate the displacement of the testicle.

Hydrocele of the spermatic cord occurs in the encysted and diffused forms. The first is an accumulation of serous fluid in an unobliterated portion of the vaginal process of the peritoneum, which probably has its origin in repeated injuries connected with developmental abnormalities. It is essentially noninflammatory and chronic in its origin and course, though a **perispermatitis** may occur and give rise to an effusion in the coverings of the cord. There are no **subjective** symptoms. Those of an objective character are the existence of a smooth, sharply defined, fluctuating, and translucent tumor, generally in front of the cord, from which it can be separated, situated below the inguinal canal and above the testicle. The skin of the scrotum is freely movable over it. The tumor does not permanently recede on pressure or change of position. Except when complicated with inguinal hernia there is no impulse on coughing. In doubtful cases the diagnosis may be established by aseptic aspiration. The affection is rather common in infancy, when it may be associated with vaginal hydrocele, but it is rare in adult life. The **treatment,** in the case of children, consists of aspiration, which frequently suffices, and, in the case of adults, in tapping and injecting pure carbolic acid. This failing, open incision and suturing the sac walls to the skin or extirpation of the walls should be practised. **Diffuse hydrocele of the cord** is rare. It consists of an acute edema of the cord, which is limited by Cooper's fascia. It may have its origin in rupture of cysts of the cord, in hemorrhages surrounding the cord, or in an interference with the return circulation in the spermatic vein after inflammation of the testicle. The **treatment** is aseptic incision and drainage, or extirpation of the cyst wall.

Spermatocele is a rare form of cystic tumor, generally the shape of an inverted pear, situated between the testicle and the epididymis and containing spermatic elements. It occurs after the age of puberty and is of slow growth. The **treatment** is tapping, or incision and drainage.

Abnormalities of the Testicles.—**Absence of the Testicle.**—Congenital absence of one or both testicles is of such rarity that many authors deny its occurrence. Probably most of the cases reported as such were instances of irregular and imperfect descent, or atrophy of the organ, though it cannot be denied that congenital nondevelopment of one or both testicles is occasionally observed. **Deficiency of the vas deferens** at one or the other of its extremities has been observed in individuals otherwise normally developed.

Supernumerary testicle is also of very rare occurrence. In most of the supposed cases of this abnormality a tumor of the epididymis, an encysted hydrocele, or a hernia is present.

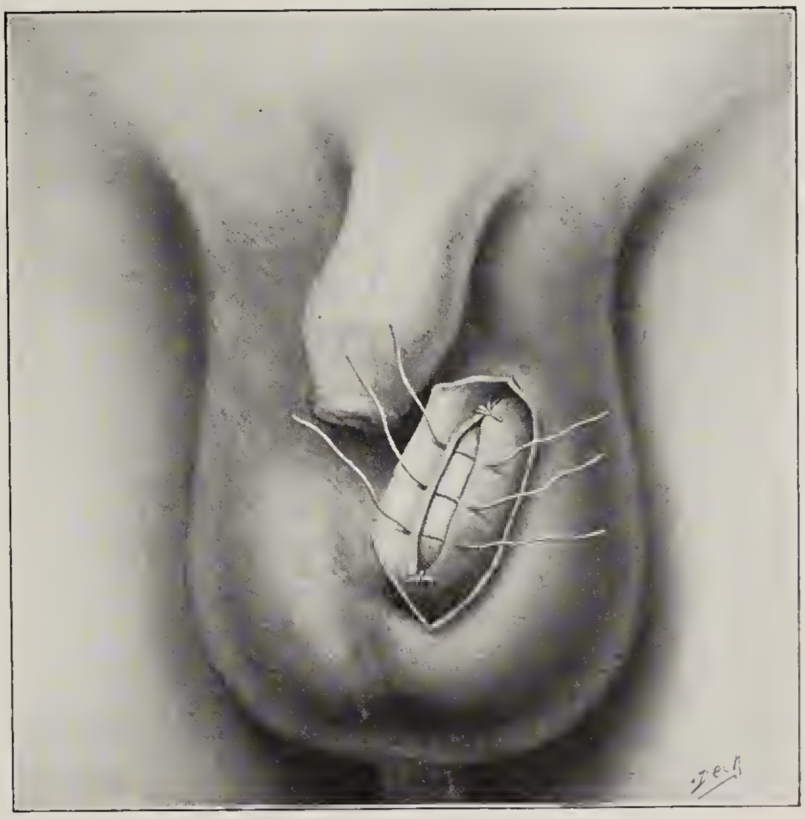

Fig. 574.—Operation for Hydrocele.

The testicle has been placed in the pocket previously made beneath the skin of the scrotum, by making a slight turn of the cord on its axis. The cut edge of the tunica vaginalis on the outer side is brought into view by this maneuver, and is sutured to the raw surface of the everted skin just behind the inner margin of the incision. The upper and lower sutures are shown tied. The testicle itself is shown lying behind the sutures remaining untied.

Malposition of the testicle from irregular or imperfect descent of the organ is rather commonly observed. There may occur absolute nondescent of the testicle, in which case it remains in the abdomen, or it may be arrested in the inguinal canal or upper part of the scrotum. In **ectopic** or **misplaced** testicle the organ is found in the groin, the crural region, or the perineum. Abnormalities in descent may be the result of peritoneal adhesions from fetal peritonitis, shortness of the cord, or limited size of the abdominal rings. In **cryptorchidism** both organs are retained within the abdomen, and, while the individual may retain sexual power and appetite, he is usually sterile, the testicle remaining soft and undeveloped. In **monorchism** but one testicle is retained, the individual possessing normal procreative powers if the other testicle is normal. Misplaced testicles are specially liable to injury, and, when in the groin, may suffer from lack of development from pressure. When situated in the crural region, or in the perineum, functional development and activity may be present. If orchitis attacks the testicle in an abnormal situation, the symptoms are comparatively severe; if within the abdomen, fatal peritonitis may result.

Treatment.—In cases of nondescent of the testicle, unless the organ occasionally slips into the inguinal canal, in which case a truss may be worn to insure its exclusion from the latter location, no treatment is indicated. Should the organ be situated in the inguinal canal in connection with a hernial protrusion, in case a radical operation for the cure of the latter is undertaken, it will be proper, if practicable, to fix the testicle in the upper part of the scrotum. **Reposition of an ectopic testicle** is a feasible operation. The testicle is exposed by a vertically placed incision and the tissues about the organ stitched to the bottom of the scrotum. With the lapse of time, traction resulting from the weight of the scrotum will more or less completely correct the malposition.

Hahn's operation consists of making a buttonhole slit through the bottom of the scrotum, and, after the testicle has been thoroughly loosened, forcing it through the slit and securing it there by two or three silk sutures. When a week has elapsed, or when adhesions have formed, the testicle is covered by the skin of the scrotum dissected from about the margins of the adherent organ (Figs. 575, 576, and 577).

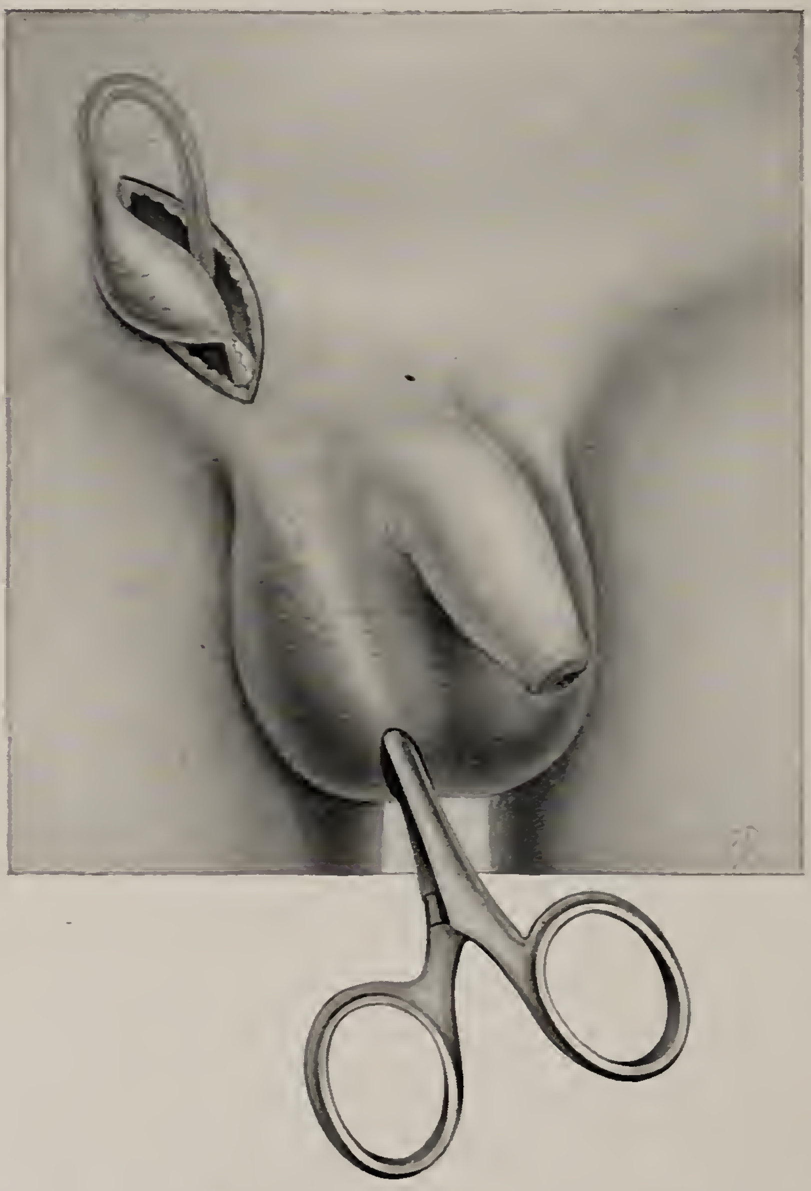

Fig. 575.—Hahn's Operation for Ectopic Testicle. First stage. Drawing down the testicle.

Atrophy of the testicle is not uncommon and follows most frequently inflammatory conditions (orchitis) and syphilitic disease; pressure from varicocele, hydrocele, and the wearing of a truss also produce it. Other causes are injuries of the brain or spinal cord, onanism, and overindulgence in sexual intercourse. Injury of the vas deferens, and too great interference with the blood-supply in the operation for varicocele, may be causes. It is observed in those mentally deficient (idiots and cretins). Finally it may occur without known cause in individuals otherwise healthy. The treatment consists in removal of the cause, when this can be ascertained. **Hypertrophy of the testicle** has not been observed, except as a compensatory condition in cases where one testicle remains undescended or has been removed in early adult life. Physiologic enlargement, occurring as the result of regular coitus at the advent of the sexual life, is not to be regarded as a hypertrophy.

Varicocele.—Varicocele is a varicose enlargement of the pampiniform plexus and veins of the spermatic cord. It occurs in about 10 per cent of adult males and is confined almost exclusively to the left side.

The principal **exciting cause** of the disease is said to be imperfect sexual hygiene in those whose tissues are lax; acute cases may result from sudden lifting or straining effort. Among the **predisposing causes** may be mentioned the absence of valves in the smaller veins, and the fact that on the left side the venous blood from the testicle empties at a right angle into the left renal vein. The **symptoms** are insidious in their onset (except in the rare acute cases) and consist of dragging sensations in the groin and back, particularly after fatigue or long standing, which are aggravated by unrelieved sexual excitement as well as by sexual excesses. In extreme cases the veins of the scrotum are involved. Neuralgia of the testicle may accompany the affection. Emotional and hypochondriac symptoms are marked features of the disease. The **diagnosis** is established by the presence of tortuous veins, which have a peculiar "wormy" feel on palpation. Hernia is excluded by the ease with which the veins are emptied in the recumbent position, and the fact that, when the patient rises, a hernia can be kept reduced by moderate pressure over the external ring; in varicocele the veins will immediately refill.

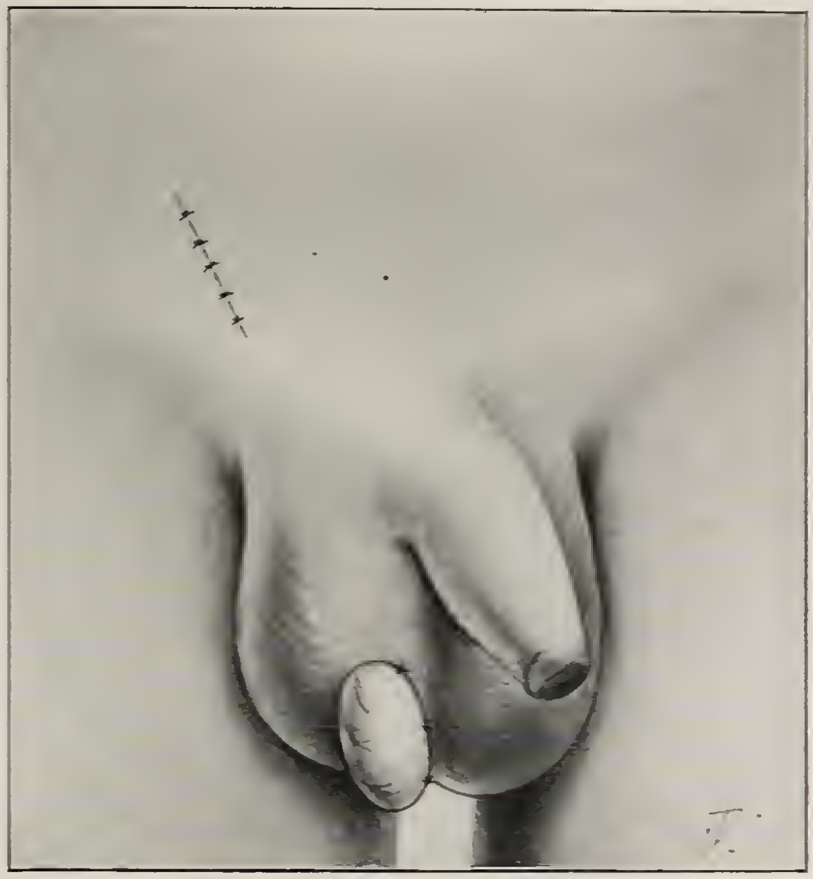

Fig. 576.—Hahn's Operation for Ectopic Testicle. Second stage. The testicle as it is temporarily placed.

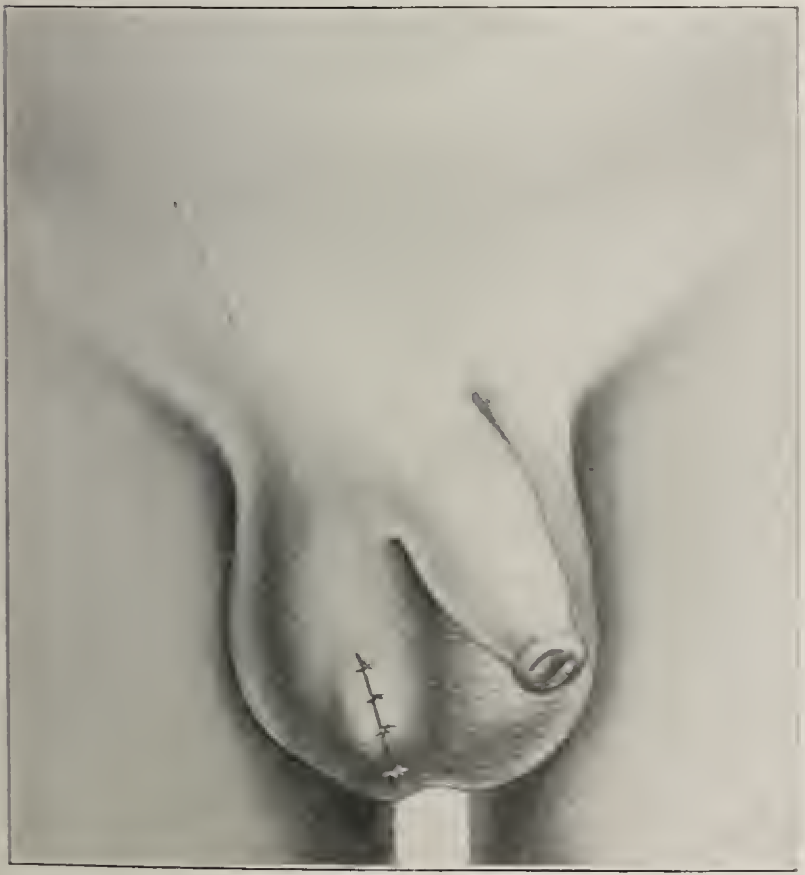

Fig. 577.—Hahn's Operation for Ectopic Testicle. Third stage.

The **treatment** consists first in assuring the patient that he is not suffering from a serious malady and second, in mild cases, in the use of such palliative measures as cold douches, sea bathing, regulation of the bowels, and a snugly fitting suspensory bandage. Severe cases and those in which the patient's mind is so concentrated on the physical irregularity as to render him morbid may be subjected to radical operation. Keyes's operation consists in **subcutaneous ligation** of the veins with the buried aseptic silk ligature. A special instrument is used by Keyes (Fig. 579). Reverdin's needle may be employed (Fig. 580). The operation is performed with the patient standing; cocain infiltration anesthesia is employed. The needle is threaded beforehand. The vas is separated by the thumb and finger of the left hand. The needle is then passed between the vas and the veins, so as to transfix the scrotum from before backward in the situation shown in the cut (Fig. 578). The eye of the needle is opened, the loop of the silk released, and one leg of the loop withdrawn on the posterior side of the scrotum until an end appears. The needle is now withdrawn only sufficiently to permit the veins to fall back to their original position against the vas, after which it is passed to the outer side of the veins and its point made to emerge a second time at the posterior puncture. Here the eye is again threaded with the silk, after which the needle is permanently withdrawn, the silk being carried along with it. By steadying the scrotum firmly, grasping the two ends projecting from the anterior puncture, and giving a rapid jerking motion to the loop, any portion of the dartos caught in the silk will be released. The ligature is now tied firmly and the ends cut short. The knot sinks out of sight in the depths of the puncture. The points of puncture are covered with a drop of collodion. The pain is readily

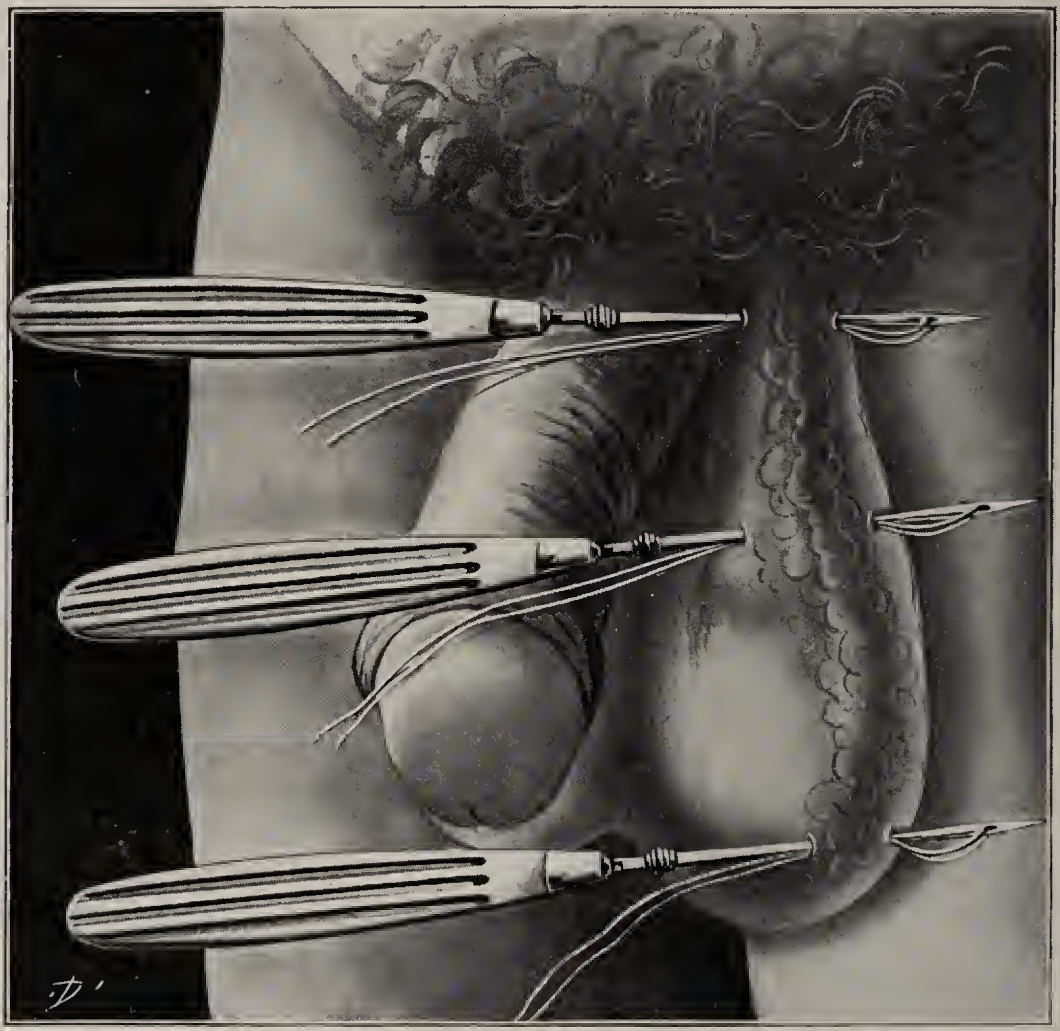

Fig. 578.—Keyes's Method of Subcutaneous Ligation of Varicocele.

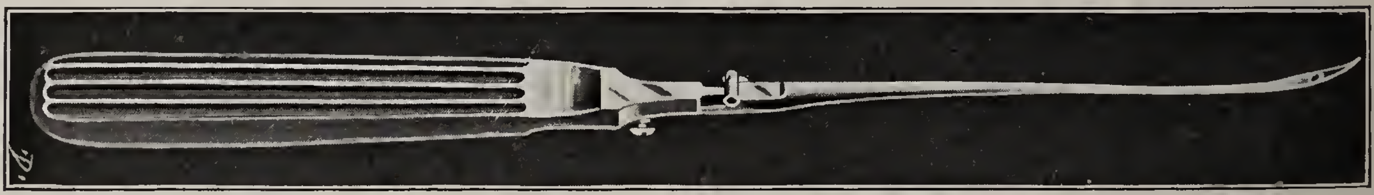

Fig. 579.—Keyes's Needle for Subcutaneous Ligation of Varicocele.

controlled by a simple anodyne. The testicle swells during the first two days and some swelling occurs also at the site of each puncture. The average confinement to bed is five days.

In cases of exceptionally large varicocele, Keyes applies one or two additional ligatures, one high up on the cord and the other below the testicle.

Where the vas cannot be positively identified (*e. g.*, in cases where the testicle is not well developed and in young individuals), **ligation by open incision** may be employed. In **Lister's operation** a single ligature is applied through a short incision where the cord passes over the pubic bone. If catgut is employed either in Keyes's operation or in Lister's operation, relapse is very likely to occur.

The Open Suprascrotal Operation with Excision of the Plexus of Veins.—The cord is grasped just below the external ring by the thumb and forefinger of an assistant and made as prominent as possible. An incision from one-half to three-fourths of an inch long exposes its coverings, which are divided layer by layer until the veins come into view. The veins and vas deferens are now together drawn out of the incision, and the vas. with its accompanying vessels, separated from the collection of veins and drawn to one side. Two catgut ligatures are applied to the bundle of veins, from an inch to an inch and a half apart, and the intervening portion excised. The ends of the ligatures are tied together for the purpose of preventing the weight of the testicle from dragging on the remainder of the cord, the organ being lifted in place at the same time. The small skin incision is now closed and collodion applied.

Where the scrotum is redundant and flabby, a vertical incision may be made and this sutured at right angles to its original axis; **partial ablation of the scrotum** may be performed in addition.

Fig. 580.—Reverdin's Needle.

Tumors of the Testicle.—Tumors of this organ, occurring in adult life, are almost always malignant. In children **enchondroma** is occasionally met with; in adults this is usually associated with malignant **adenoma** and **sarcoma.** A combination of the two latter (**adenosarcoma**) is the most frequently observed tumor of the testicle. **Cystic disease** of the testicle may occur in myxomatous degeneration (**myxosarcoma**). Obliterated and distended seminal vesicles may form true cysts in connection with sarcoma (**cystosarcoma**). **Carcinoma** is more rarely observed than other varieties of malignant disease. **Benign fungus** of the older writers results either from abscess of the organ (tuberculous orchitis) or from the breaking down of a **syphilitic orchitis.**

Fibroma of the tunica vaginalis, as well as **myoma, sarcoma,** and **enchondroma** of that structure, has been observed.

Sarcoma of the Testicle.—This occurs, as a rule, either between the first and the tenth year, or between the thirtieth and the fortieth year. The round-celled and the spindle-celled variety are observed with about equal frequency. Lymphosarcoma is occasionally observed, in which case rather rapid dissemination is the rule. Both testes may be affected in the round-celled variety. Hyaline cartilage may be present, which may follow the shape of the tubules of the organ; the tumor may be composed almost entirely of cartilage. In children the spindle cells may present the appearance of transverse striation resembling voluntary muscle-fiber. Cystic spaces may be present. Contrary to the rule in sarcoma, glandular infection rapidly occurs, the aortic glands finally becoming affected through the intimate anatomic relations of the lymphatics of the testicle with the lymphatics of the spermatic cord and the lumbar glands. Dissemination through infection of the veins also occurs.

Malignant disease of the testicle advances rapidly and leads to considerable enlargement of the organ. Involvement of the epididymis and cord quickly follows. The cavity of the tunica vaginalis is early occupied with fluid (hydrocele complicating sarcoma) and renders the diagnosis difficult at this stage. Cystic sarcoma sometimes gives a delusive sense of fluctuation on palpation. Differential diagnosis between simple hydrocele and sarcoma is still further embarrassed by the fact that fibrous thickening of the tunica vaginalis sometimes masks fluctuation. **Lumbar pain** is frequently complained of in malignant disease of the testicle.

Recurrence after extirpation usually takes place in the stump of the cord, and the case, as a rule, is further inoperable. If the patient survives sufficiently long, general dissemination is certain to occur.

Extirpation of the Testicle (Castration).—This operation was formerly performed to improve the singing voice of children. With rare exceptions (*vide infra*) it is now exclusively indicated in malignant disease and in tuberculosis of the testicle and epididymis. Exceptionally it may be indicated in **hematocele,** with fibrous degeneration of the testicle and tunica vaginalis. It may also be indicated in **chronic suppurative orchitis with multiple fistulas,** the organ being already destroyed, in cases of ectopic testicle when the testicle is the seat of degenerative changes or recurring attacks of inflammation, and when it is implicated beyond extrication in a coexisting hernia. Further, in certain cases of prostatic hypertrophy it is claimed that extirpation of the testicle is followed by the lessening in size of the enlarged prostate and an amelioration of the symptoms due to incomplete emptying of the bladder (White). The results, however, do not justify the claims originally made for this method of treatment of prostatic hypertrophy. Finally, in certain cases of inguinal hernia in which previous operative measures have failed, recurrence has taken place, and a truss cannot be worn, the operation may be justified.

Operation.—The incision extends from the level of Poupart's ligament to the lower limit of the organ. The latter is grasped in the left hand, the layers covering it divided, the connective tissue surrounding the cord and tunica vaginalis separated, the inguinal canal opened, the vas deferens isolated, and the remainder of the cord tied *en masse* with catgut as high up as possible. These structures are divided, and the vas deferens is pulled out from its connective-tissue attachments (**avulsion of the vas deferens**). In this manner the vas is sometimes removed as far as the seminal vesicle. Some surgeons, fearing infection from the open end of the vas, particularly in tuberculous cases, prefer to divide on the same level as the rest of the cord and apply the fine point of the thermocautery to the cut end. The testicle and its investing tunic are now rapidly extirpated, all bleeding points secured, the inguinal canal closed, the skin wound sutured, and the wound drained through a separate opening made at the most dependent portion of the scrotum.

Dressings.—Thick layers of sterilized cotton should be placed between the scrotum and the thighs and around the root of the penis. Aseptic gauze in copious folds or layers is applied over the wound and drainage-tube. The patient's pelvis is elevated on a dressing block (Fig. 581) or an inverted basin and the dressings secured by the turns of a spica, the end of the penis protruding between the turns. A square of oiled silk with a hole cut in its center is pinned in position to protect the dressings from urine. When the bladder is emptied the patient is to be carefully turned to the opposite side and a proper urinal, or bottle with a large mouth, used as a receptacle.

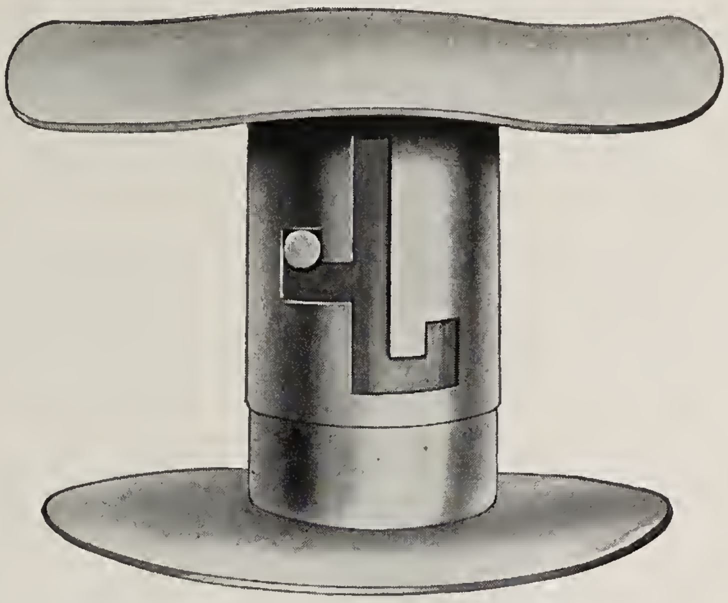

Fig. 581.—Volkmann's Dressing Block.

THE PENIS AND URETHRA

Injuries of the Penis.—Crush injuries of the corpora cavernosa and the corpus spongiosum may occur in connection with other severe traumatisms in the neighborhood. Isolated injury of the first named usually takes place when the penis is in a state of erection, and during violent coitus, the organ striking with great force against the woman's pubic region (**fracture of the penis**). Hemorrhage into the corpora cavernosa follows, and if coincident injury of the corpus spongiosum and urethra occurs, urinary extravasation results. In a case in my hospital service the entire organ was crushed by the jaws of a vicious horse while the patient, a farm laborer, was urinating in the stall alongside the animal. Amputation became necessary.

The **treatment** of these injuries will be governed by the extent of the damage inflicted. Simple rupture of the corpora cavernosa is best treated by placing the patient in the recumbent position and applying iced cloths. A lateral bending of the organ in erection from the presence of new connective-tissue deposits in the cavernous structure of the injured side, this limiting the lengthening of that side during erection, is a sequel of the accident. When the rupture extends to the urethra and this is opened, a catheter must be introduced and kept in place, frequent irrigations of the bladder by boric acid solutions kept up, and on the first sign of urinary extravasation a perineal section (see page 269) or a suprapubic cystotomy (see page 323) performed, the region of commencing extravasation being at the same time opened up freely and the incisions packed with iodoform gauze.

Inflammation of the Prepuce and Glans Penis.—Inflammation of the mucous membrane covering the glans penis is called **balanitis.** When the mucous membrane lining the prepuce is inflamed, the affliction is called **posthitis.** When both are inflamed, **balanoposthitis** is present. **Predisposing causes** are a too long, a too short, or a too tight prepuce, a prepuce with a tight orifice or a short frenum. The **exciting causes** are venereal disease, vegetations, herpes, etc. This disease, as well as **eczema** of the prepuce, occasionally occurs in connection with **diabetes,** and is due under these circumstances to decomposition of the urine with which the parts are so frequently bathed. A subacute form, which finally becomes **chronic,** is sometimes present in middle-aged men; this may result in epithelioma.

The **symptoms** of simple posthitis are redness and moisture, together with a spongy condition of the prepuce. The parts are covered with a whitish coating. When **balanitis** coexists, the glans has a mottled appearance due to a macerated and eroded condition of the epithelium. A vesicular eruption on the glans may precede ulceration.

Secondary posthitis may be due to venereal disease, vegetations, or herpes. Considerable redness, swelling, and discharge accompany it. An infiltrated and indurated form may be present, with subacute symptoms and absence of true ulceration, though superficial erosions may occur in primary or secondary syphilis (**specific balanitis**). The papular eruption, when due to secondary syphilis, sometimes develops into wartlike growths (**condylomata lata**). Permanent contraction of the prepuce may follow.

The **treatment** of simple posthitis consists in washing the parts twice daily with warm water and dusting with a powder consisting of equal parts of boric acid, bismuth subnitrate, and calomel ("A B C" powder). Or, the lead and opium wash or the lotio nigra may be applied on a thin layer of cotton. Erosions are to be lightly touched with a nitrate of silver solution, one dram to the ounce. In secondary posthitis the prepuce should be retracted and the cause removed, after which the measures already mentioned should be employed. In persistent or recurring cases, particularly in elderly men, circumcision should be performed. In diabetic cases thorough washing after each act of urination should be insisted on in order to prevent irritation in the prepuce and gangrenous inflammation. If the tension is great in these cases, it is better to operate at once by making a simple dorsal incision or by removing a V-shaped piece of the prepuce.

Herpes progenitalis is an inflammatory affection manifested by the appearance of vesicles on the balanopreputial membrane, usually in the sulcus behind the corona; it may appear on the inner surface of the prepuce, or at either side of the frenum, at the meatus, on the free margins of the prepuce, on the integument of the penis or in the pubic region. It is usually only a temporary condition; occasionally ulceration occurs and simulates chancroid. When erosions are present, they may simulate mucous patches, or when single, even a superficial chancre. Soft chancres are differentiated by the history of the case, the presence or absence of lymphatic enlargements, and auto-inoculability in cases of chancroid. In chancre the base is indurated and stiff, the color is deep red, and the surface smooth and glistening. In herpes the vesicles generally occur in groups, the base is soft and pliable, the edges sharply cut and without much elevation, the color is pinkish or light red, and the surface moist and fresh. When herpes is situated on the integument about the vulva of the female, it is difficult to differentiate it from mucous patches. A neuralgic form has been observed which is closely allied to herpes zoster.

The **treatment** of herpes progenitalis consists in cleanliness and the use of soothing powders or lotions (see Posthitis, page 256). When the parts become very dry, the latter are preferable. Circumcision may be necessary to prevent recurrence in cases of ill-fitting prepuce. Erosions and ulcers should be touched with the nitrate of silver solution every second or third day. When pain is present, the lead and opium wash will be useful.

Venereal warts or **verrucae** are characterized by hypertrophy of the papillae, proliferation of the connective tissue, and increased vascularity. When situated on the integument (generally between the scrotum and the thigh) they are dry and hard; on the mucous surface (the sulcus behind the corona), they are moist and soft. They may be pedunculated or sessile, single or grouped in cauliflower-like masses. Subpreputial warts may attain a large size and produce phimosis and ulceration, or sloughing of the prepuce; they secrete a viscid fluid with a most disgusting odor. Uncleanliness, urethritis, and an unusually moist prepuce in young adults are the causes of venereal warts.

In the **diagnosis** venereal warts of the acuminate variety, due to the causes just mentioned, should not be confounded with the condylomata lata of syphilis or with epitheliomas. Condylomata lata occur as flat papules in syphilitic subjects and later on become roughened, moist, and vegetating. Epitheliomas occur in older individuals and are of slower growth.

The **treatment** of venereal warts is as follows: The parts are to be washed and dried, painted with a 10 per cent solution of cocain, and the warts painted superficially with a dram to the ounce solution of corrosive sublimate in collodion every day or two, a powder consisting of equal parts of oxid of zinc, tannin, and calomel being dusted on. The action of the sublimate is both astringent and caustic, and the contraction of the collodion causes pressure on the papules; the powder tends to keep the parts dry. The sublimate application is made by the surgeon. The patient is directed to wash the parts and apply the powder twice a day (Guiteras). Some prefer the quicker method of cutting away the warts with scissors and cauterizing the base. Painting the warts with persulfate of iron, as well as burning them away with the thermocautery, is also advocated. Thorough curetting with the sharp spoon under cocain, the dusting powder of Guiteras afterward being used, is the best method of treatment.

Phimosis.—Inability to draw the prepuce back over the glans is called phimosis. The condition is often **congenital. Accidental phimosis** exists when retraction is prevented by inflammatory conditions of the prepuce, swelling of the glans, or the presence of new growths or ulceration. Congenital phimosis gives rise to considerable irritation in childhood and retention of urine may occur from this cause. Certain serious nervous troubles are said to develop from its presence. Later in life, balanitis, constant itching and inordinate excitability of the organ, seminal emissions, vesical tenesmus, incontinence of urine, and imperfect development of the genitals may occur. Coxalgia, epileptiform convulsions, chorea and muscular incoordination have also been claimed to be due to this cause. Hypochondriasis is often present.

The whole or a part of the mucous membrane may be **adherent. Preputial calculi** may be present in the adhesions in the adherent prepuce or between the adhesions and the glans. There may be an abundance of loose skin about the end of the prepuce, even when the latter is adherent. When the foreskin is retracted, the orifice of the urethra can be seen surrounded by mucous membrane.

The **treatment** of congenital phimosis is **circumcision.** The operation is performed as follows: The prepuce is drawn well forward and seized opposite the corona with a pair of narrow-bladed thumb forceps, or the phimosis forceps may be employed (Fig. 582, A). The forceps are closed on the prepuce as the glans retracts. With curved scissors or a sharp scalpel all structures in front of the forceps are cut away. When the forceps are removed, the skin retracts and leaves the mucous aspect of the glans still encircling the prepuce (Fig. 582, B). One blade of a pair of scissors is passed beneath this and the mucous membrane slit up on the dorsal aspect as far as the corona. The whole of the mucous membrane is now retracted by separating it from the glans, any adhesions present being loosened. Hemorrhage is arrested by tying the vessels with fine catgut. The edges of the reflected mucous membrane are stitched to the skin edges by interrupted catgut sutures, the corners at the commencement of the vertical incision being trimmed away. In adults it is usually necessary to trim away more of the mucous membrane than in children (Fig. 582, C). The stitching may be omitted in very young children.

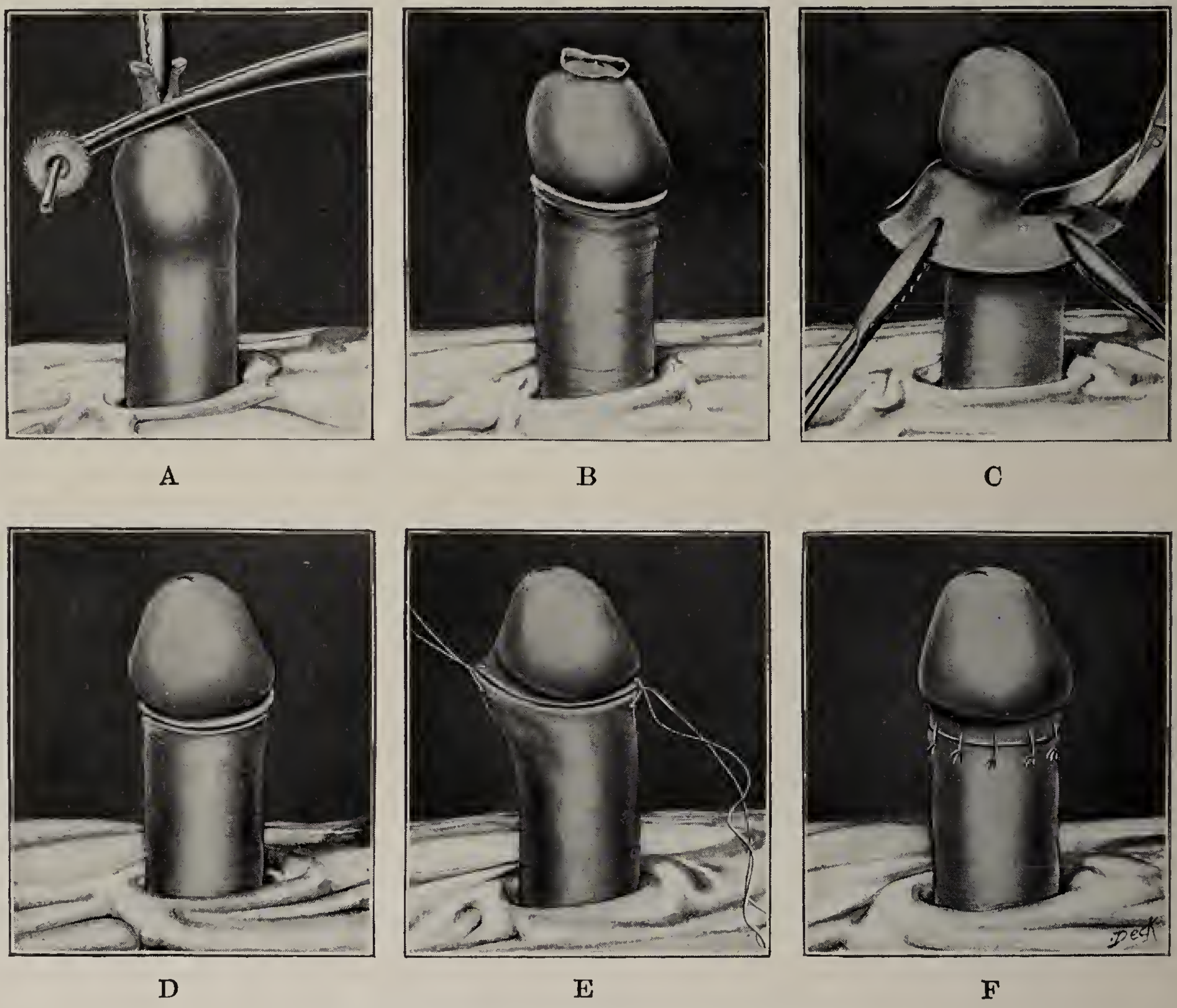

FIG. 582.—THE OPERATION OF CIRCUMCISION.

A, Application of forceps; B, appearance after first cut; C, trimming the mucous membrane flaps; D, appearance after flaps have been trimmed; E, insertion of the first and second suture; F, operation completed.

The **dressings** consist of several superimposed layers of sheet lint, in the center of each of which a hole has been cut. These are smeared with oxid of zinc ointment or carbolized vaselin. The holes in the lint should be only just sufficiently large to permit the glans to be forced through. The edges of the hole rest on the corona snugly and prevent the sutured edges of the foreskin from being crowded forward over the glans in the subsequent swelling. Watchful care is necessary to prevent the latter, under any circumstances.

In **accidental phimosis** the treatment consists first in disinfectant and soothing or cleansing injections beneath the prepuce. Operative measures consist of a dorsal incision with or without excision of a V-shaped piece, or lateral incisions; finally, circumcision may be performed. Either of the first two may have to be resorted to in order to treat properly the underlying inflammatory condition. Circumcision is best performed after the inflammation has subsided.

Paraphimosis.—This term is applied to the conditions induced by the constricting influence of a narrow prepuce when retracted behind the glans. It may occur either purposely, accidentally, or during coitus. It occurs generally in cases of venereal disease from a slight swelling of an already narrow or naturally retracted prepuce. When recent, it may be easily reducible; after a few days, however, there is a plastic exudation as a result of the congestion, impeded circulation, and serous effusion. Adhesions form, and strangulation, ulceration, and perhaps sloughing of the penis follow. The organ is enlarged, the glans swollen and tender, and the normal coronary sulcus deepened by the swelling. The constricting band is sometimes completely hidden from sight in a deep sulcus behind a brawny collar of swollen mucous membrane, which may cover the coronary sulcus and even overlap the glans itself. A second roll of swollen mucous membrane, less marked than the first is usually present. The constriction is between these two (Fig. 583). (For Treatment of Paraphimosis, see page 278.)

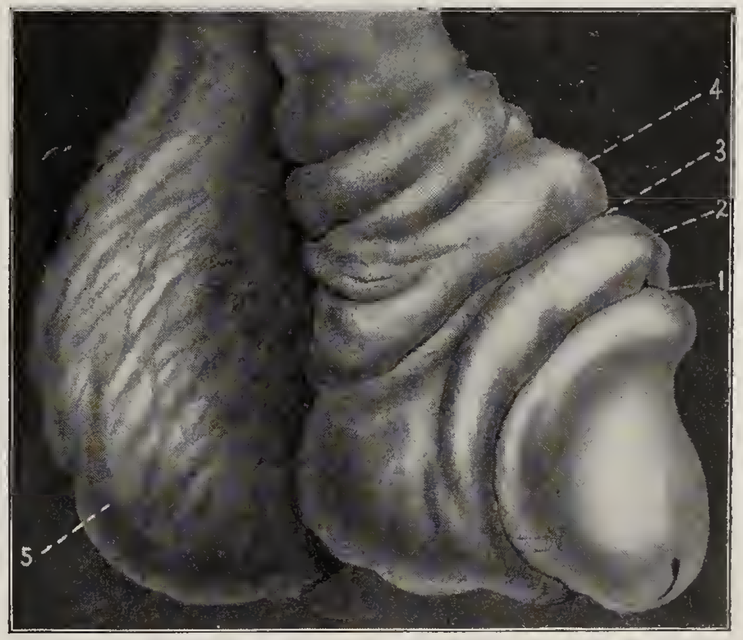

Fig. 583.—Paraphimosis.

1, The coronary sulcus; 2, edematous and brawny collar of mucous membrane; 3, deep furrow the actual seat of constriction; 4, ridge of swollen skin; 5, scrotum.

Chancre.—A chancre is the initial lesion of syphilis. It is an **infective granuloma** resulting from contact with the discharges from another chancre, from the secretion of mucous patches and moist syphilitic papules, from syphilitic blood, or from the secretion of any secondary lesion, suppurative or otherwise. The lesions of active hereditary syphilis are also infectious. The infection may be due to direct contact or may be transmitted by mediate agencies, such as instruments, nursing bottles, etc. The infection cannot arise, as far as is at present known, from a lesion of the tertiary stage. It is the first expression of a constitutional infection, it appears at the point of inoculation, and its clinical course constitutes the **primary stage of syphilis.** The patient himself cannot be reinoculated from the secretion of the sore, hence it is said to be **non-autoinoculable.** The property which the sore has of conveying infection to those not otherwise protected by a previous attack of the disease is known as **heteroinoculability.**

The sore makes its appearance in not less than ten days after exposure and it may be delayed for many weeks. The average term is three weeks. The lesion is rarely multiple.

Chancres are divided into the following varieties: (1) **Erosion:** a deeply stained purplish patch at the site of a very superficial abrasion. There is neither induration nor ulceration. This is a very rare form. (2) **Papule:** a papule-like indurated area beneath the epidermis without ulceration. This is a very common form. (3) **Ulcer:** an indurated area with elevated edges which ulcerate, exposing a smooth raw surface which bleeds easily and from which a thin watery fluid is secreted (**Hunterian chancre**). It rarely suppurates. This variety is more commonly observed than the first and less commonly than the second. It is the papule-like second variety which has undergone ulceration from some irritation, such as friction, caustic applications, etc.

Syphilitic Bubo.—Shortly after the occurrence of induration of the initial lesion the lymphatic glands anatomically related to the site of the sore undergo an almost absolutely painless enlargement. The glands enlarge to various sizes, from that of a pea to that of a walnut; they very rarely suppurate. The glands on the side of the penis where the chancre is situated, as well as in the corresponding inguinal and femoral regions, are affected. If situated at the frenum, the glands of both sides may be involved. The lesion is a hyperplasia of the gland structure itself and is due to an absorption of the infective agent. In strumous individuals these glands may become enormously enlarged. The bubo following a syphilitic chancre consists of a chain of enlarged and movable glands. It is hard, insensitive, slow of growth, usually of small size, rarely suppurates, is covered by normal skin, not amenable to local treatment, invariably present, followed by secondary syphilis, and disappears under the internal use of mercury.

In about six weeks after the occurrence of buboes in the groin or at the time when a secondary eruption of roseola appears, there is a general involvement of the lymphatic system, which persists until after the secondary eruption disappears. This has no special surgical importance in this connection, except in the cases of **postcervical** and **epitrochlear enlargements,** which are diagnostic. (See The Course of Acquired Syphilis, Vol. I, page 194.)

The **treatment** of chancre consists in washing the parts twice or more daily with a warm salt solution (dr. j to O j), drying the parts with absorbent cotton and dusting with equal parts of calomel and subnitrate of bismuth. Cleansing with hydrogen peroxid, followed by wet dressings of dilute solutions of carbolic acid, may be employed if the dry dusting-powders are not efficient. Excision of the sore and indurated area is useless and cauterization is not indicated unless there is a tendency to phagedena. Syphilitic buboes in the groin rarely suppurate and usually require no treatment. If they tend to enlarge before the diagnosis of syphilis is fully established, inunctions of a 10 per cent ointment of ichthyol and lanolin will be useful. If the patient has advanced sufficiently far in the disease to make the diagnosis of constitutional syphilis indubitable, this being based on the occurrence of the secondary eruption, mercurial ointment makes an excellent application to the bubo. But under no circumstances should mercury be employed in a manner to affect the course of the general infection until constitutional symptoms develop. Not only the diagnosis but the prognosis of the disease in the particular case may be determined by the character of the eruption, an ecthymiform or mild papular eruption occurring in a less serious infection and an early pustular eruption in a more virulent one. The importance of withholding mercury in the primary stage of syphilis is apparent, when it is considered how important it is that the secondary eruption should not be prevented from making its appearance.

A syphilitic chancre when permitted to run its natural course may last many months, though it usually disappears after the secondary symptoms have made their appearance. A dark brown or copper-colored spot remains, however, until the disease is cured. Reappearance of the induration may precede the appearance of some fresh, though remote, lesion.

Chancroid.—This is an ulcer with sharply defined and undermined edges; it makes its appearance shortly after sexual intercourse. It is rarely seen as late as the tenth day and usually appears within five days. It first manifests its presence by a pustule, which ruptures and becomes the seat of an ulcer. The base of the latter is grayish and foul, and the discharge is profuse, purulent, and locally infectious, as shown by fresh chancroids which appear where the discharge flows over the parts. This sore, therefore, is autoinoculable as well as heteroinoculable. There is an area of inflammatory redness around the ulcer and pain is not an uncommon accompaniment. The edges of the ulcer are not indurated, except in cases where caustics have been used or where there is a mixed infection; hence the name **"soft chancre."** An inflammatory induration may gradually merge into the healthy tissues, but this differs markedly from the sharply outlined induration of a syphilitic or so-called **"hard chancre,"** the induration of the latter being confined almost exclusively to the edges. A high degree of inflammation, accompanied by a rapidly distinctive ulcerative process, is known as **phagedena.**

Chancroid is a purely local venereal sore. It is not accompanied or followed by constitutional symptoms, other than those of a septic character.

Inflammatory bubo accompanies chancroid in about one-third of the cases. It consists of one inflamed and immovable mass, usually unilateral. It presents an inflammatory hardness, is very painful, large, and of rapid growth, often suppurates, and the overlying skin is red and adherent. It demands local treatment, is not improved by mercury, but on the contrary may grow worse under this treatment, and is not followed by secondary syphilitic eruptions or general lymphatic involvement. (Compare with syphilitic bubo.) The lesion is a suppurative adenitis, with infection of the paraglandular connective tissue following rupture of the gland capsule, or infection through the latter.

In the **differential diagnosis** between chancre and chancroid it is necessary to bear in mind the following points:

Chancre. (1) This appears in from two to four weeks; (2) it appears at the site of the original inoculation; (3) there is a sclerosis at the base; (4) the primary bubo rarely suppurates; (5) the lesion is simple and may appear (*a*) as an erosion, (*b*) as a nonulcerating indurated papule, (*c*) as an ulcer, either shallow or deep, (*d*) as a mixed sore, *i. e.*, either an implantation of syphilitic virus on a chancroid, or an infection of a chancre with pus microorganisms; (6) the secretion is scanty; (7) it is not autoinoculable.

The above points should be compared with the following:

Chancroid. (1) This has no period of inoculation; (2) there is no sclerosis; (3) in the adenopathy the buboes are of the inflammatory type; (4) the lesion is pustular and frequently multiple; (5) its secretion is autoinoculable; (6) its floor is covered with grayish sloughs; (7) the destructive ulceration may be phagedenic in character, with extensive involvement of the skin and subcutaneous connective tissue.

The **treatment** of chancroid consists, in severe cases, of thorough cleansing, which may include spraying with a half strength 15 volume solution of hydrogen peroxid, drying the parts, and disinfecting the ulcer with pure carbolic acid. The ulcerated surface is dried in a few minutes after the application of the carbolic acid, then fuming nitric acid is applied. Iodoform or calomel is then dusted over, and the patient directed to bathe the parts with warm normal salt solution, to spray the ulcerated surface with hydrogen peroxid, and to apply the powder every three or four hours. The application of the carbolic acid and nitric acid may be preceded by a few drops of a 50 per cent solution of cocain. In mild cases the cauterization may not be necessary. **Spreading phagedena** is best treated locally by a more powerful caustic, such as bromin; if this fails to arrest the destructive inflammation, the thermocautery is to be applied. At the same time a supporting diet is to be ordered, and iron, quinin, and alcoholic stimulants prescribed.

Accompanying inflammatory bubo in the groin is to be treated the same as suppurative adenitis. The application of compresses wet with a 2.5 per cent solution of carbolic acid and covered with cotton batting and oiled silk serves a good purpose. Painting with tincture of iodin is an old-time remedy, from which good results, however, are rarely if ever obtained. A 10 per cent ichthyol ointment is useful. Whatever application is made, the patient must be ordered to bed and a snug spica applied so as to make pressure over the glands. As soon as suppuration is evident the mass is to be freely incised, curetted, scoured with iodoform gauze, and the interior cauterized with pure carbolic acid. After two minutes' exposure to the carbolic acid the latter is neutralized with 95 per cent alcohol. There is usually an area of bluish infiltrated skin overlying the bubo at this stage. This must be cut away. The wound is then packed with iodoform gauze. In cases in which suppuration is slight or absent, convalescence can be shortened by dissecting out the entire diseased mass and sewing the skin edges together so as to obliterate the cavity formed by the removal of the mass of glands, without drainage. Even in cases in which suppuration has taken place this result may sometimes be obtained by swabbing the interior with pure carbolic acid, afterward neutralized with alcohol, and closing the wound.

If the chancroidal ulcers are hidden away beneath an inflammatory phimosis, the foreskin must be slit up on the dorsal or two lateral aspects. The resulting freshly cut edges must then be thoroughly cauterized. A formal circumcision is not necessary and is almost always unsuccessful when attempted, the suture-holes becoming infected and each forming a fresh chancroid.

A "**mixed sore**" partakes of the characteristics of both a hard and a soft chancre. It is the result of double infection with the virus of syphilis and poison of chancroid. This, however, need not necessarily take place at the same exposure, nor need the symptoms manifest themselves simultaneously.

Tumors of the Penis.—The majority of the tumors of the penis spring from the skin. Cysts arise either from the sebaceous glands at the root of the penis or from those at the corona glandis. They belong to the class of retention cysts. **Elephantiasis** is rare. It affects the prepuce almost exclusively. It develops symptoms as a result of inflammatory edema and may attain considerable size. It is a common disease in the East and is usually due to the **Filaria sanguinis hominis. Cartilaginous and bony tumors** are sometimes found in the septum between the cavernous bodies; they are analogous to the penis bones of some of the lower animals. **Gummas** are also observed in one or the other of the cavernous bodies. These interfere with erection, and so a curved shape of the organ arises, with its convexity toward the healthy side.

Polypi of the urethral mucous membrane are observed. Urethritis may result from their presence. They may be recognized by their protrusion from the meatus or their existence may be demonstrated by endoscopic examination. **Cysts of Cowper's glands** are very rare; they appear at the perineum.

Carcinoma of the Penis.—This usually begins as a wart; when it commences as an ulcer, it is liable to be mistaken for a chancre. It is most common between the ages of fifty and sixty. It attacks either the prepuce or the epithelium of the glans. Phimosis is believed to favor its development through the irritation arising from the retention of smegma.

In the natural course of the disease the penis is destroyed; the inguinal, and in some cases the lumbar glands as well, are infected. Involvement of the urethra leads to the formation of urinary fistulas.

Diagnosis.—The age of the patient will assist in the diagnosis. Cancer occurs after the fiftieth year, venereal warts earlier in life. The age of the growth itself also aids in the differentiation. The history of exposure to syphilitic infection will help to identify the hard chancre. Carcinoma is of a steadily progressive character; hard chancre soon becomes stationary and then gradually subsides. In soft chancre, though there is a progressively ulcerative action, this is not preceded by an infiltration beyond the margins of the ulcer, which is the case in carcinoma. Microscopic examination is to be resorted to in differentiating between papillomatous carcinomas and condylomas. **Involvement of the inguinal lymphatic glands** is not common in simple condylomas; it may be present in either carcinoma or chancre. Phagedenic gumma is also to be carefully distinguished from cancer of the penis by the microscope and by the therapeutic test.

Prognosis.—The disease runs its course in from six months to a year, but patients sometimes live much longer. Secondary deposits may occur occasionally. In the absence of the latter, and with the removal of the entire organ, including the detachment of the penile crura from the pubic arch, as well as all identifiable glands in the groin, whether these are palpably diseased or not, cure may be hoped for in a definite proportion of carefully selected cases. The glandular inguinal swelling may be due to carcinomatous infection or to septic involvement; in the latter case the prognosis is more favorable, and even in the former a relatively favorable prognosis as to recurrence may be given, if early operation, with complete clearing out of both inguinal regions, is performed.

Preputial calculi are occasionally observed. They result from incrustation of desquamated epidermis and smegma, with urates and phosphates. These concretions sometimes grow to a large size. Care should be taken not to mistake one of these hard bodies lying beneath the foreskin for a carcinomatous infiltration. Relief of the coexisting phimosis is indicated. This will likewise serve to clear up the diagnosis.

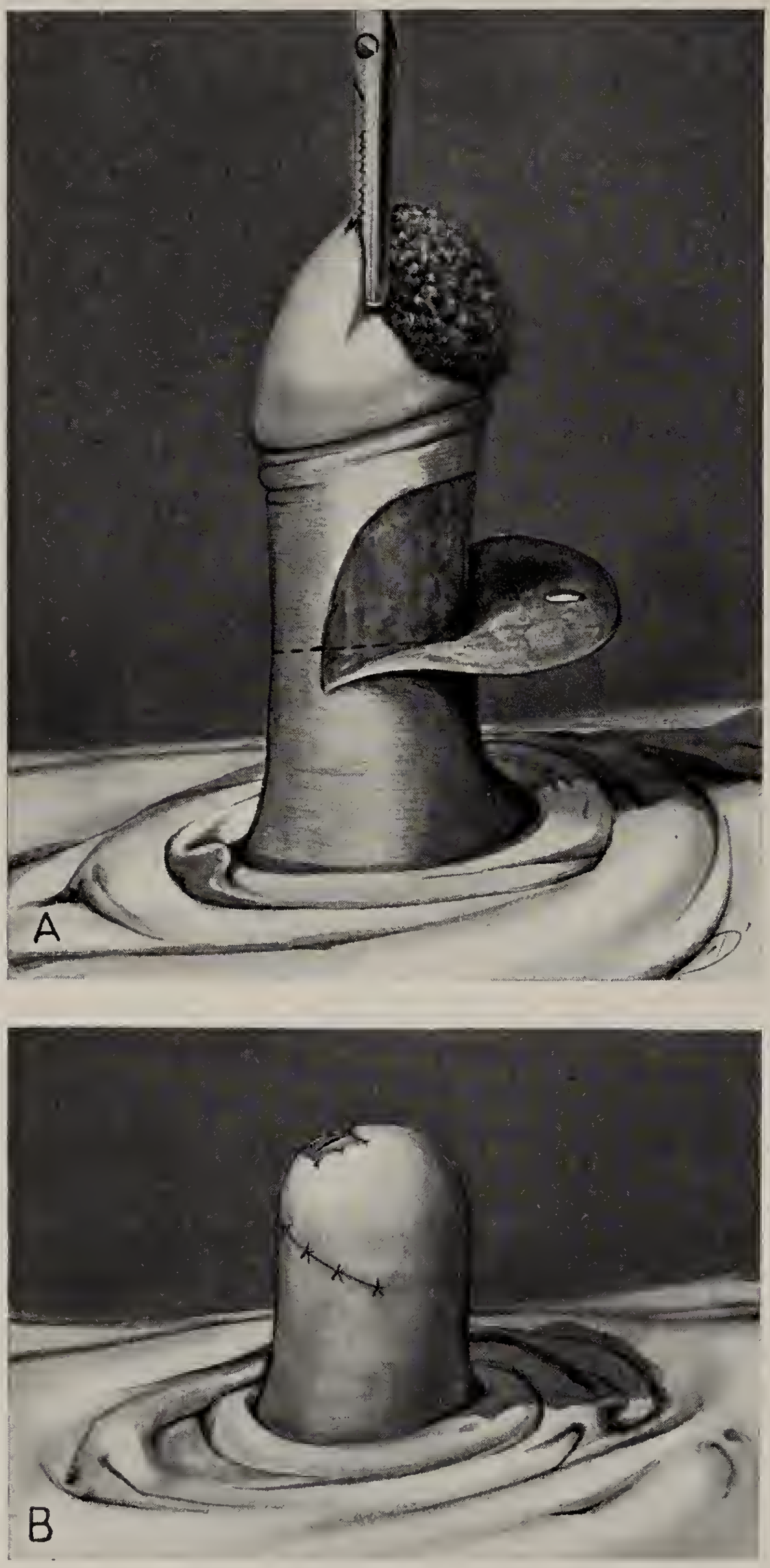

Fig. 584.—Amputation of the Penis.

A, Flap dissected back and slit cut for the reception of the stump of the urethra. The dotted line shows the point of circular incision. B, The flap sutured and the stump of the urethra secured in the opening in the flap.

Treatment of Tumors of the Penis.—In all operative procedures about the penis careful asepsis is particularly required, on account of the special proneness of these parts to erysipelas. **Cysts** and **elephantiasis** are to be extirpated. **Condylomas** are to be removed by means of scissors, and their base cauterized by means of either chromic or nitric acid. An astringent powder, consisting of equal parts of savin tops (*Juniperus sabina*) and alum, may suffice in small growths, without excision. **Cysts of Cowper's glands** are extirpated from the perineum. **Urethral polypi** are excised by means of the scissors. Gummas are not operable; antisyphilitic treatment will suffice.

Amputation of the penis is the only resource in carcinoma of that organ. The amputation should always extend well beyond the utmost limits of the infiltration. The combined dorsal flap and circular method is to be preferred in cases in which not more than two-thirds of the organ is to be removed. A piece of rubber tubing is to be tied about the root of the penis to control the vessels. This may be kept from slipping forward by two pins passed through the skin in front of the tubing. A dorsal skin flap is dissected back, commencing well beyond the border of the indurated mass in the underlying parts marking the limits of the disease. A slit is cut near the apex of this flap for the reception of the stump of the urethra. The amputation is then completed by a circular sweep of the knife, the line of incision passing somewhat in front of the base of the dorsal flap (Fig. 584, A). The tube is now removed, the vessels secured, and the flap sutured in position, the stump of the urethra being secured in the opening in the flap (Fig. 584, B). Both inguinal regions should be opened up and thoroughly cleared out, every trace of lymphatic glandular structure recognizable as such being removed, as a routine measure.

The patient should be catheterized for the first few days in order to avoid the soiling of the dressings. If the urine can be kept from contact with the wound, primary union may be expected.

INTRA-URETHRAL INJURIES

Foreign Bodies in the Urethra.—Injuries of the urethra from within occur either from the unskilful use of instruments, or from foreign bodies introduced for the artificial production of sexual excitement. The injury is most frequently limited to the membranous portion and particularly to the posterior wall of the canal. Urinary extravasation occurs less frequently in this class of cases than in injuries received from without, for the reason that the opening to the **false passage** produced by the instrument is closed, valvelike, by the advancing stream of urine. Exceptions to this will be found in those cases in which the injury is inflicted close to a tight stricture. Hence, the *locus minoris resistentiae* is already established and the inflammation extends easily. Abscess from infection of the para-urethral connective tissue occurs, and fistulous openings follow, from which pus and urine escape.

Injuries caused by the introduction of foreign bodies are most often observed (1) at the period of life when the sexual impulse is first felt, from the thirteenth to the fifteenth year; (2) in elderly persons who endeavor in this manner to arouse their waning sexual power. Almost all conceivable articles capable of being introduced into the urethra have been found therein. Pieces of broken catheters and, in fact, whole instruments which have slipped in have been found in those who have entered the "catheter life."

Smooth objects thus introduced almost invariably tend to pass backward into the bladder, where they form the nucleus for stone. This results, in the majority of cases, from unskilful attempts at removal. In attempting to push the foreign body forward, the patient (and even the surgeon) succeeds only in crowding the urethra over the foreign body, the latter advancing further and further at each attempt. Foreign bodies which fit the canal somewhat closely may be expelled by the stream of urine.

Urethral calculus may result from arrest of foreign bodies, such as needles, pins, and pointed fragments of a vesical calculus; even a small but complete calculus from the bladder may be arrested along the urethral tract. Any one of these may become the nucleus of incrustations deposited by the salts of the urine.

Para-urethral abscess occurs from ulceration of the mucous membrane resulting from the presence of foreign bodies. The suppurative focus in the connective tissue which follows is sometimes found, on incision, to contain the foreign body. The abscess may point either at the pendulous urethra or at the perineum.

The symptoms of a foreign body in the urethra depend on the obstruction to the stream of urine and the irritation of the urethral walls induced by its presence. Burning pains in the canal, radiating to the end of the penis and to the bladder as well, and intensified by urination (if, indeed, this is not impossible from the size and character of the obstruction), are felt.

The **diagnosis** is established by the history, by external palpation if the foreign body is situated in the penile urethra, and by rectal palpation if it is in the membranous or prostatic portions. **Direct visual inspection** by means of the urethral endoscope will reveal the position and the nature of the foreign body.

Treatment.—Though foreign bodies have remained in the urethra for years and then have been successfully removed, they should nevertheless be removed as soon as possible in order to avoid unpleasant and even serious consequences. Small objects near the meatus may be removed with fine-bladed forceps. In the case of those more posteriorly situated the endoscope will be of assistance. Long pointed objects (hairpins and needles) may be pushed through the anterior urethral wall and extracted in this manner when other measures fail. If there is a head on these which prevents them from being withdrawn through the wound thus made (these objects being usually introduced with the head first), they may be withdrawn as far as the head, reversed, and the latter, now pointing upward, pushed out of the meatus. If it is not long enough to be thus extruded, it may be held firmly until it can be grasped by the urethral forceps. The bullet forceps is a convenient instrument for grasping and extracting rough foreign bodies, broken off catheters, etc., from the urethra.

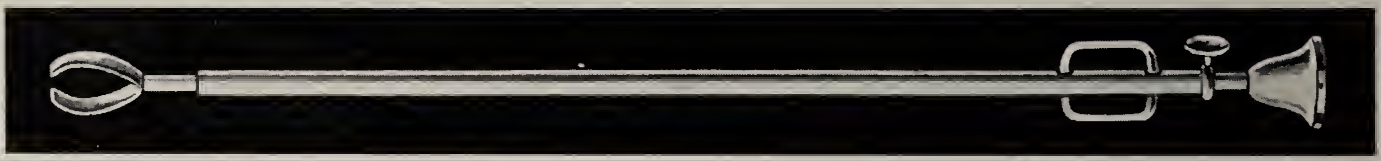

Fig. 585.—Hunter's Urethral Forceps.

In the removal of foreign bodies from the urethra, the latter must be grasped firmly in order to prevent the body from advancing still further. The urethral forceps of Hunter (Fig. 585), the straight alligator forceps (Fig. 586, A), and the articulated curet of Leroy d'Etiolles (Fig. 586, B) are useful. A large straight lithotrite tube, as well as Thompson's urethral divulsor (Fig. 586, C), has been successfully employed. In the employment of the former the finger of an assistant is passed into the rectum and made to occlude the urethra beyond the foreign body, while the surgeon slightly distends the urethra with the tube in position, by a small quantity of water; by a quick, sucking movement of the aspirating bulb the foreign body is drawn into the tube.

Urethral incision must be employed if efforts at extraction fail. The operation is comparatively easy if the object is situated in the penile urethra. The object itself is grasped as a guide and the incision made directly on it. After removal the wound is closed at once by sutures, which serve the double purpose of arresting hemorrhage and preventing **urethral fistula.** A soft-rubber catheter is left *in situ* for a few days. If the foreign body is situated at or posteriorly to the bulb, the operation of **perineal section** (see page 269) or **external urethrotomy** (see page 287) is indicated. If near the **meatus,** this may be enlarged by the blunt convexed tenotome (**meatotomy**).

Rupture of the Urethra.—The **perineal portion** of the urethra is most frequently injured by force applied from without; the pendulous portion rarely so. Certain ruptures of the cavernous bodies, as well as injuries of the spongy investment of the urethra, with laceration of the latter, occurring while the organ is in a state of erection (the so-called **fractures** and **dislocations** of the organ) are sometimes observed (see page 255).

The **mechanism** of rupture of the urethra, as usually observed, is as follows: A blow on the elastic skin of the perineum as a result of falling astride a hard object forces the urethra against the sharp edge of the middle puboprostatic ligament. The urethra is less elastic than the skin and therefore ruptures subcutaneously. Lateral rupture may occur from contusion against either sharp descending ramus of the pubes. Fractures of the pelvis in which the os pubis is involved not infrequently produce contusion and rupture of the urethra, as do also dislocations of the pubic symphysis. In the first instance the fragments impinge on the fixed membranous urethra; in the second the rupture takes place by traction, the bones overriding one another and returning at once to their normal position.

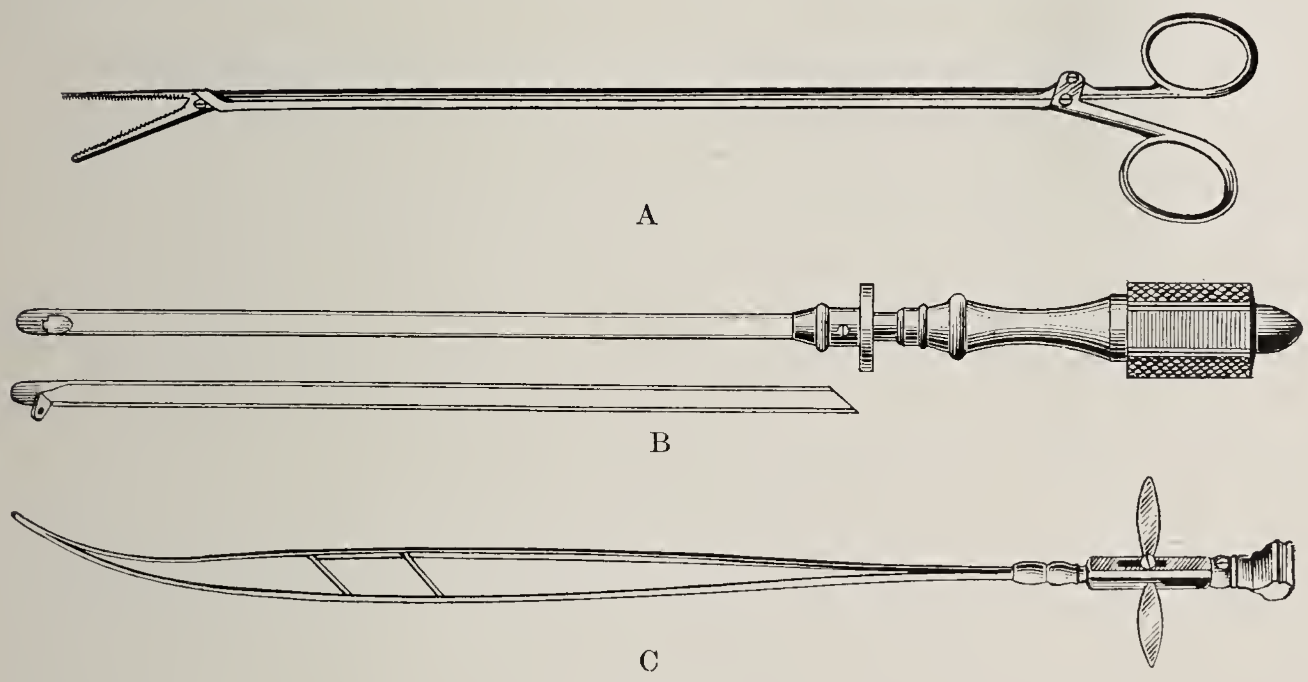

Fig. 586.

A, Straight alligator forceps; B, Leroy d'Etiolles's urethral scoop; C, Thompson's divulsor. The latter instrument is shown with the blades separated after introduction. The foreign body falls between the blades, where it is grasped by closing the latter.

Subcutaneous hemorrhage gradually extending over the perineum, the **escape of blood from the urethra,** and increase of swelling in the perineum from **extravasation of urine,** when unsuccessful attempts at urination are made, are the prominent symptoms of rupture of the urethra. If only the posterior wall is injured, it may be possible to pass a catheter into the bladder by hugging the anterior urethral wall with the beak of the instrument. Should this succeed, the instrument must be left *in situ* (see Treatment of Rupture of the Urethra, page 269). **Circular rupture,** however, is the rule, and catheterization is impracticable; persistence in the effort may do incalculable harm. Swelling of the proximal end of the torn canal occurs; this, together with the fact that the surrounding connective tissue will permit only a limited escape of urine, soon leads to **retention of urine.**

The **situation of the rupture** may sometimes be determined by the course taken by the extravasated urine. If the triangular ligament is taken as an anatomic landmark, it will be noticed that a rupture behind the posterior layer of this structure leads to extravasation of urine into the perineum and in the neighborhood of the anus, while a rupture in front of the anterior layer will cause the extravasation to find its way along the deep layer of the superficial fascia into the scrotum and up on the abdominal wall. In uncomplicated rupture of the membranous urethra the urine is confined between the two layers of the triangular ligament until sloughing takes place or an incision releases it.

In **incomplete rupture** or **contusion** of the urethra only the spongy tissue may be involved, the internal mucosa and the external fibrous coat escaping entirely. In the space thus formed a small accumulation of blood takes place, which projects into the cavity of the urethra and obstructs its lumen (**interstitial rupture**). Or, rupture of the submucosa may occur, the rent communicating with the urethra only. Extravasation, if it occurs under these circumstances, takes place secondarily.

Finally, the urethra may give way at a point behind an old stricture from long-continued pressure and the changes which the urethral walls undergo in consequence; or extravasation may take place after injuries to the canal occurring as the result of the injudicious use of metal instruments (see Intra-urethral Injuries, page 265).

The **diagnosis** is based on (1) the history of a blow on the perineum; (2) the appearance of blood at the meatus (pressure on the perineum will cause its appearance, which under other circumstances may be delayed); (3) increase in the swelling in the perineum when the patient attempts to empty the bladder; (4) the occurrence of inflammation of the perineal structures, with pain and local swelling; later, tension, redness of the skin, and fever are present. In the meanwhile retention of urine and, in incomplete rupture, failure of attempts at catheterization will have occurred.

Urinary Infiltration and Its Consequences.—As long as the extravasated urine remains acid, its effects on the tissues are comparatively slight. With the occurrence of alkaline decomposition and the production of ammoniac compounds, fermentative processes take place. More or less extensive septic inflammatory complications follow, these varying with the course of the fermentation and the virulence of the infecting agents present, from the exceptional simple localized abscess to the more common extensive phlegmonous inflammation and sloughing of the connective tissue. If the rupture is in the penile urethra, the penis becomes greatly swollen, the swelling reaching its maximum near the point of escape. If behind the bulb, infiltration of the scrotum will occur, from which locality the extravasation will pass between the spine of the pubes and the symphysis, finally reaching the abdominal wall. At the membranous urethra the extravasation will be confined between the layers of the triangular ligament, from which it subsequently escapes by processes of suppuration and sloughing. At the prostatic urethra, *i. e.*, behind the posterior layer of the triangular ligament, the extravasation may find its way to the anal region in the perineum by following the course of the rectum; or the pelvic fascia may give way at its thinnest portion near the puboprostatic ligament and permit the extravasation to spread through the subperitoneal connective tissue.

In whatever direction the urine finds its way, except in the exceptional cases in which a strictly localized abscess is situated near the surface and from which a simple incision gives exit to a mixture of pus, blood-clot, and urine, its presence in the tissues gives rise to progressive septic phlegmonous inflammation and fatal septicemia, unless speedy measures of relief are instituted. In the cases in which a localized purulent collection is emptied externally, a **urethral** or **urinary fistula** results. The ruptured urethra heals by granulation, **cicatricial** or **traumatic stricture** resulting.

The Treatment of Rupture of the Urethra at the Perineum.—Very rarely in complete rupture will the surgeon be enabled to pass a catheter into the bladder. In partial rupture and in severe contusions, should an instrument fortunately reach the bladder and the contents of the latter be evacuated, it should be allowed to remain, and preparations made for an immediate external urethrotomy, since in true rupture, whether partial or complete, even though the retention be relieved by the catheter, permanent catheterization fails to prevent abscess and urinary infiltration.

Where no instrument can be passed, the case assumes a most serious character from the commencement, and the patient's life will depend on the promptness with which the perineum is opened and exit given to the effused blood and extravasated urine. It will be necessary to perform **perineal section** or **external perineal urethrotomy without a guide** under these circumstances (*vide infra*).

Suprapubic puncture or **aspiration of the bladder above the pubes** may be employed as a temporary measure to relieve the retention and prevent urinary extravasation until measures for the more certain and safer operation of opening the perineum can be taken. Under no circumstances should it be employed other than as a temporary palliative measure.

Perineal Section.—This term is applied to operations performed for the relief of retention and the prevention of urinary extravasation following rupture of the urethra where no instrument can be passed, as well as those performed on strictures, whether gonorrheal or traumatic, which will not admit even the smallest instrument. Such strictures are usually deeply seated and are to be approached only by the perineal route. Perineal section should be promptly resorted to in indubitable rupture of the urethra. Where an instrument can be passed as a guide, whether in partial rupture or contusion of the urethra, or in cases of stricture, opening the urethra from without is called **external urethrotomy** (see page 287).

When performed after extravasation has taken place in urethral rupture, perineal section should be supplemented by free incisions in localities where infectious processes have already begun, and by the thorough removal of all necrotic tissue. When performed immediately after urethral rupture, it will afford an opportunity of dealing with the ruptured urethra itself.

The Operation.—The patient is placed in the lithotomy position and the perineum shaved and cleansed. In adults cocain anesthesia may suffice. A straight grooved metal staff with a hooked extremity (Wheelhouse, Fig. 587) or, in the absence of this, a grooved and tunneled sound (Fig. 599), or even an ordinary sound, is to be introduced to the seat of rupture, or the point of the stricture, and entrusted to an assistant, who grasps it in such a manner as to cause the perineum to bulge prominently. An incision is made in the raphe from the scrotum nearly to the anal margin. In case of rupture, if the injury involves the bulb the effusion of blood will be found beneath the **superficial fascia;** if the membranous portion has been injured, the **deep perineal fascia** will be opened up before the effusion is reached. The clots are turned out and the parts thoroughly cleansed. The staff is now passed out of the perineal wound, the proximal end of the urethra identified, and a thread passed through its wall on each side and made into a loop for further identification, and for purposes of retraction.

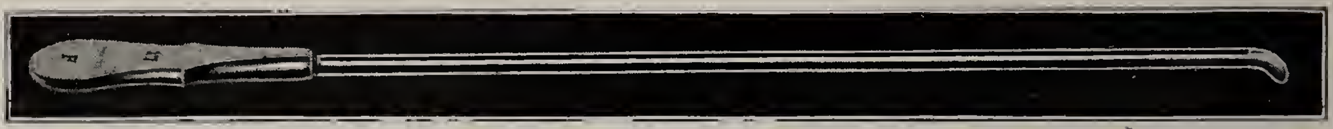

FIG. 587.—WHEELHOUSE'S STAFF.

In cases of **stricture** the fibrous cord representing the urethra is identified and followed backward to the ampullated portion behind the commencement of the coarctation. The urethra should be opened well up anteriorly, so as to be certain to secure at least a quarter of an inch of healthy tube immediately in front of the stricture. If the Wheelhouse staff is used, the urethra is opened upon the groove of the instrument, the walls of the urethra secured by threads laterally placed, and the staff turned with the groove toward the pubes and its button extremity hooked into the upper angle of the urethral wound. This may expose the opening of the stricture and permit the passage of a small grooved director (Fig. 588), on which, as a guide, the entire strictured portion of the canal is freely incised. The little eye instrument known as Weber's canaliculus knife (Fig. 589) is an excellent instrument for this purpose. A narrow-bladed straight bistoury is next run along the groove to insure complete division of all bands or other obstructions. A larger director is now substituted for the smaller one, and along this a Teale's gorget (Fig. 604) is passed into the bladder, its entrance into which will be signalized by a gush of urine. The staff is now withdrawn, and all obstructions in the penile urethra having been removed by an internal urethrotomy performed at this stage, a full-sized steel sound is passed

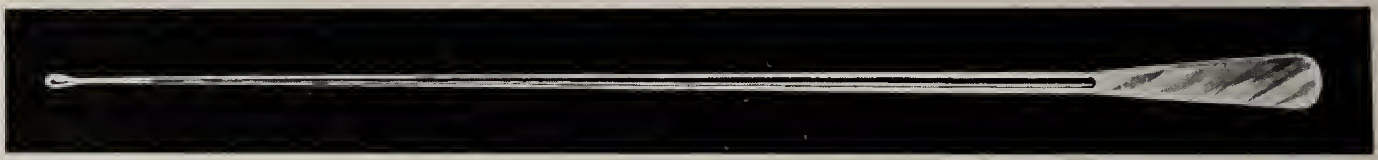

FIG. 588.—GOULEY'S GROOVED SILVER PROBE OR DIRECTOR.
The handle can be bent at any angle.

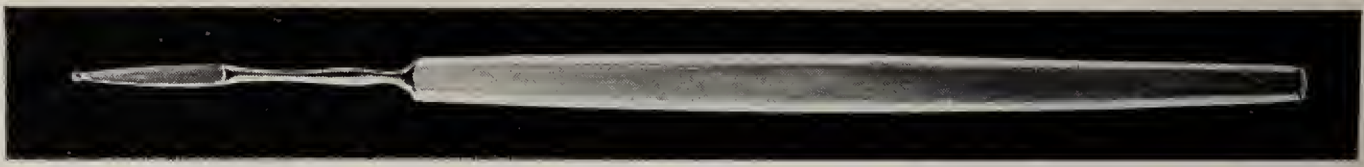

FIG. 589.—WEBER'S CANALICULUS KNIFE, ADAPTED BY GOULEY FOR DIVISION OF STRICTURE OF THE URETHRA IN THE OPERATIONS OF PERINEAL SECTION AND EXTERNAL PERINEAL URETHROTOMY.

along the urethra to the gorget and then along this as a guide to the bladder. The sound is now withdrawn and a large soft catheter or drainage-tube passed, in the grasp of a pair of slender forceps, along the gorget into the bladder, where it is secured in position by a safety-pin passed through the wall of the tube, and tapes fastened thereto and attached to loops of adhesive plaster placed above the iliac crest on each side.

In **rupture of the urethra,** when the canal is completely severed, the most difficult portion of the operation consists in securing the retracted proximal end. It forms a freely movable round cord which eludes the search. The difficulties are increased by the presence of blood, which flows freely from the injured urethra. If a few drops of urine can be forced from the bladder, the appearance of this in the depths of the wound will serve as a guide. If the proximal end cannot be identified by these methods, **suprapubic cystotomy** should be resorted to, and **retrocatheterization** practised.

The ruptured ends having been secured, the connective tissue, wherever infected by the extravasated urine, is to be opened up freely, irrigated with a 1 : 1000 solution of mercuric chlorid and the incisions tamponed with 10 per cent iodoform gauze wrung out of 50 per cent alcohol. In cases of recent development an attempt may be made to **suture the torn ends (urethrorrhaphy,** König). Under these circumstances **suprapubic cystotomy** is performed for the purpose of **direct bladder drainage.** A soft-rubber catheter is placed in the urethra (not in the bladder) and allowed to remain there for several days as a splint. Chromicized catgut is the best suture material for the urethra. The sutures should not encroach on the mucous membrane.

In cases in which septic processes are already under way, suture of the urethra will be useless and a large catheter is to be passed through the wound and into the bladder for permanent drainage. The tube is prevented from slipping into the bladder by a large safety-pin passed through and across its walls. The wound in the perineum is tamponed around the tube with iodoform gauze, and a cushion of sterile gauze having in its center an opening for the passage of the tube is placed over the perineum and secured by a T-bandage. The projecting end of the catheter or drainage-tube is connected with a longer tube which is led to a proper receptacle placed on the floor beside the bed and containing a 1 : 1000 mercuric chlorid solution. The dressings are changed whenever soiled.

In case the rupture is **anterior to the membranous urethra** the bladder may be drained by incising the latter and passing a catheter through the opening thus made, the injury to the urethra being repaired by suture. The perineal wound should always be allowed to close by granulation.

The complication of **suppurative hepatitis** after injury to the bulb of the urethra occurs through the medium of a septic thrombus, which may find its way from the bulb of the corpus spongiosum to the dorsal vein of the penis, thence into the vesicoprostatic plexus and the hemorrhoidal plexus, and through these to the inferior mesenteric vein and portal circulation. In old men the veins of the bulb and vesicoprostatic plexus become considerably enlarged.

In the after-treatment of perineal section and external perineal urethrotomy the diet should be at first restricted to fluids. Urination takes place through the tube and pains must be taken to keep this patent. Blood-clots may enter the tube from the bladder and block its lumen or become impinged against its opening in the bladder. Arrest of flow through the tube may also result from spasms of the bladder wall, the latter being forced against the eye of the tube. Finally, the tube may slip out of the bladder, the sphincter vesicae closing behind it. The introduction of hydrogen dioxid through the tube will generally clear the latter and at the same time break up clots in the bladder. Persistent bleeding will usually yield to tight tamponade of the parts about the vesical neck with gauze moistened with a 1 : 1000 solution of adrenalin chlorid. This failing, exposure of the bleeding point and ligation are indicated. If cystitis is present, it should receive appropriate treatment, the necessary irrigation being carried on through the drainage-tube.

In cases of rupture with extravasation of urine septic foci will require the same antiseptic treatment as infectious phlegmonous inflammation elsewhere. Wherever brawny conditions or even tenderness or a suspicious redness of the skin occurs free incisions should be promptly made and these should be packed with aseptic gauze wrung out of 50 per cent alcohol.

As soon as the proximal end of the urethra has become fixed in the wound, usually at the end of four days, the drainage-tube is abandoned and a full-sized sound passed every few days. The prevention of a permanent perineal urinary fistula after these operations depends on maintaining the normal caliber of the urethra in front of the site of the stricture or the rupture. For this purpose sounds are passed at intervals of every two or three days, until the perineal opening is closed, which usually occupies from three to six weeks.

In cases in which the urethra has been sutured, either after rupture or in connection with urethrectomy (see page 285), the catheter employed as a splint may be withdrawn at the end of four days. The normal caliber of the urethra should be maintained by the passage of a full-sized sound two or three times a week until the instrument slips in easily. The patency of the suprapubic opening will usually be maintained without difficulty. **Semipermanent catheterization** (thirty-six hours continuously, followed by an interval of three hours and a repetition of the first) may be necessary finally to facilitate the complete closure of this opening when the necessity for its presence has ceased, *i. e.*, on closure of the perineal opening.

Acute Urethritis.—Acute inflammation of the urethra may be the result of traumatism and nonspecific infection combined, such as follows the rough use of unclean instruments. It may likewise occur in connection with injuries to the penis in violent and ill-directed performance of the sexual act. Other causes are a foreign body in the urethra, such as a calculus, a permanent catheter retained for too long a time without removal and cleansing, irrigating injections, etc.

In the **treatment of traumatic urethritis** the cause should be removed when possible, the urethra irrigated with boric acid solution, 1 : 1000, followed in some cases by a two-grain to the ounce injection of sulfate of zinc.

Urethritis resulting from the abuse of alcoholic stimulants, particularly beer and champagne, in conjunction with sexual excesses, is prone to occur in cases in which slight inflammatory conditions already exist. It is specially likely to occur in the congested area behind an old stricture. **Gouty urethritis, herpetic urethritis** from invasions of the canal by herpes, and **eczematous urethritis** are also sometimes observed. In all of these the discharge is comparatively slight. The possibility of the existence of a chancre within the urethral canal should not be overlooked. The presence of a hard lump felt from without will awaken suspicion and the use of the endoscope will establish the diagnosis.

Gonorrheal Urethritis.—This is the most common, as well as the most important inflammation of the urethra. Its active and efficient infectious agent is the gonococcus of Neisser. No urethral inflammation, however high its grade, abundant its discharge, or however close its simulation of the other clinical features of gonorrhea, can be considered as gonorrheal urethritis without the presence of this microorganism. Simple contact of the unabraded mucous membrane of the urethra with the discharge from any person having the disease is sufficient to cause gonorrheal urethritis.

The **period of incubation** varies from one to fourteen days. The characteristic symptoms make their appearance, however, in from three to five days. As a rule, if the attack is a recurrence, the period of invasion will be shorter; in first attacks the period is longer.

The affection may occur as a subacute form and remain limited to the fossa navicularis, or as a violently acute inflammation of the entire urethral tract.

The attack comes on with itching and burning sensations, the escape of mucopurulent material from the meatus, and frequent and painful urination. These symptoms vary with the intensity of the inflammation. There is redness and eversion of the meatus and a puffy swelling of the parts. **Chordee** or painful erection is present to a greater or lesser extent, particularly at night. The corpora cavernosa expand normally, but the partially obliterated erectile tissue of the corpus spongiosum, which is more directly involved in the inflammatory process than the other portions of the penis, on account of its proximity to the mucous membrane and submucous connective tissue, prevents the filling of this structure with blood and it remains rigid and inflexible. As a rule, it is curved in a downward direction. In rare instances the corpus spongiosum escapes and the corpora cavernosa become inflamed, in which case the arching is in the opposite direction. Hemorrhage may occur during erection. Pain is referred to the pendulous urethra. Tenderness is also present in this region. Phimosis or paraphimosis and balanitis may occur as complications. Constitutional disturbance is rare in uncomplicated cases. If the inflammation is confined to the navicular fossa, the symptoms gradually lessen and cure may take place without treatment. In other cases the infectious inflammation extends posteriorly through the medium of the epithelial structures of the mucous membrane.

The **diagnosis** of acute gonorrheal urethritis is made on the basis of the red and swollen meatus, the creamy discharge, painful micturition (ardor urinae), chordee, and a history of exposure to the possibility of infectious coitus. It is not always possible to obtain truthful statements concerning the latter. Its differentiation from the so-called **bastard gonorrhea,** which may be sufficiently acute to simulate it closely, as well as from other forms of simple urethritis, depends on the demonstrated presence of the gonococcus of Neisser.

The condition of the urethra after an attack of acute inflammation is such as to constitute a predisposing cause of both relapses and recurrences. In true gonorrhea the gonococcus will be found in the discharge during the attack (**relapsing gonorrhea**). On the other hand, the discharge of a recurring simple urethritis is free from such evidence.

The **treatment** of urethritis will vary with the grade of the inflammatory action, the amount and character of the discharge, and the cause of the inflammation. Simple urethritis will usually yield to strict cleanliness, bland diet, the avoidance of alcoholic drinks, beer, etc., as well as of strong coffee, and acids, spices, and condiments. This rigid dietary need not be maintained after the acute stage has passed. Rest in bed is useful in some cases. Excessive bodily exertion is harmful. Sexual intercourse must be avoided. The patient should drink plentifully of water, milk and Vichy water, or buttermilk, in order to dilute the urine as much as possible. The penis is to be immersed in hot water during micturition to relieve dysuria.

The results of the internal administration of so-called antigonorrheal remedies are varying and somewhat uncertain. Alkalis are more or less useful to aid in rendering the urine bland and unirritating. Liquor potassae is employed in acute conditions and the citrate of potash in chronic cases. These should be administered two hours after eating. Of **specific remedies,** balsamic drugs are the most generally employed. These in the order of their usefulness are as follows: balsam of copaiba, oil of yellow sandalwood, and cubebs. The first two are best given in capsules, or they may be prescribed in syrup of acacia and peppermint water in connection with citrate of potash. Sandalwood oil should be used in the earlier stages and copaiba later in the disease. Cubebs may be prescribed in powder; the oleoresin, however, in from 10- to 15-minim doses in capsules, is the preferable form. If given in the acute stage or in large doses, it may irritate the neck of the bladder. Fluid extract of hyoscyamus and, on occasion, deodorized tincture of opium will be required for excessive pain.

Astringent injections are useful in the declining stages of the disease. The simplest and best of these is a solution of zinc sulfate, 2 grains to the ounce; Liquor plumbi subacet. dil.; solutions of permanganate of zinc, 1 : 4000 to 1 : 1000; and sulfocarbolate of zinc, 0.5 per cent to 1 per cent, are also recommended. The syringe employed should have a blunt nozzle (Fig. 590), which should be pushed into the meatus and held there for from fifteen to thirty seconds, in order to retain the injection.

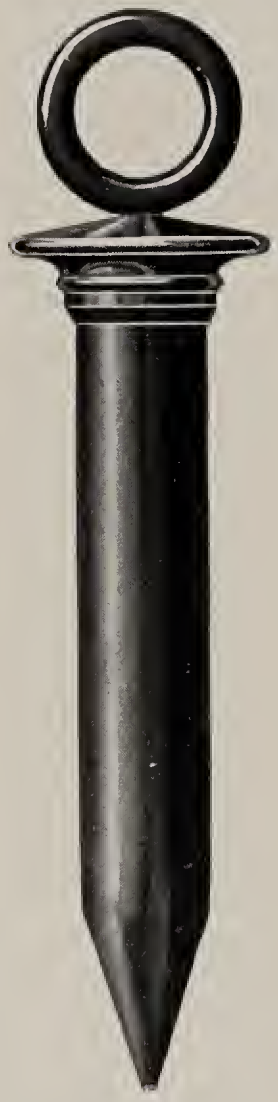
FIG. 590.—Blunt Nozzle Urethral Syringe.

Soothing injections are sometimes indicated, such as solutions of cocain hydrochlorate (2 per cent to 4 per cent), injected a few minutes prior to urination, and morphin acetate (1 grain to the ounce). A 4 per cent solution of the nonalcoholic fluid extract of hydrastis is sometimes efficacious.

In indubitable **gonorrheal urethritis** the above measures of treatment, both general and local, are called for. In addition, **antibacterial irrigation** of the urethra is to be employed. About one quart of a warm corrosive sublimate solution (1 : 100,000 to 1 : 30,000) or permanganate of potassium (1 : 8000) is used to flush out the anterior urethra by means of the Janet or Valentine irrigating apparatus (Fig. 591), about five minutes being occupied in the process. The two-way urethral nozzle of Chetwood is useful for this purpose (Fig.

592). If posterior urethritis is present, after the anterior urethra is thoroughly flushed out, the posterior urethra is to be irrigated by means of a No. 18 French soft-rubber catheter introduced until the bladder is reached and then withdrawn an inch. From 4 to 12 ounces of the irrigating fluid is used, the greater portion of this flowing into the bladder. This the patient expels on withdrawal of the catheter. Daily or, if the discharge is free, twice daily irrigations give the best results. Posterior irrigation is usually postponed until about the fourth day, and is indicated when, the discharge from the anterior urethra being thoroughly washed away, the urine is cloudy immediately afterward.

If the irrigation causes pain, it should be suspended for a few days and oil of sandalwood given until the severe inflammatory symptoms subside, when it should be resumed. The treatment should be continued until the gonococci disappear from the urine or until the discharge has been thin and watery for three or four days.

Posterior urethritis may sometimes prove rebellious to treatment and require **instillations** for its final cure. Solutions of nitrate of silver (1 : 1000) are most effective in its control. A trial of sulfate of thallin in 20 per cent solution may be made before resorting to the nitrate of silver solution. A 2 per cent solution of protargol, gradually increased to a 10 per cent solution, is most useful in chronic cases. The solution should be freshly prepared for each case. Deep urethral instillations should be made at intervals of forty-eight hours. The instillation syringe of Keyes is the best instrument for the purpose (Fig. 593). The bladder should be emptied beforehand.

If the discharge persists, the urethra should be examined for inflamed follicles or granular patches by the urethroscope (Fig. 606). These should be treated by applications of strong nitrate of silver solution, made directly through the urethroscopic tube. The use of the sound every two or three days is sometimes beneficial in this stage of the disease.

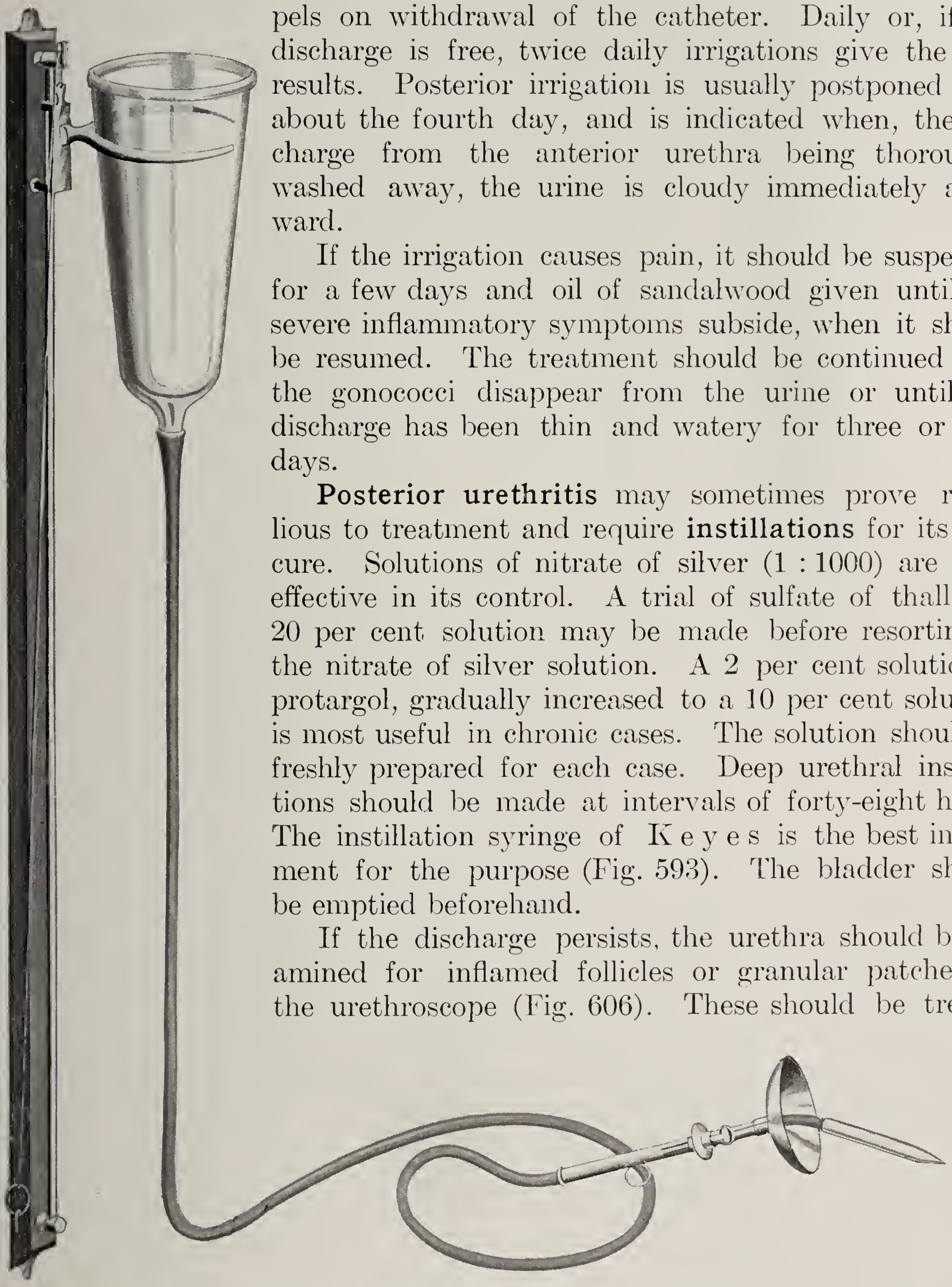

FIG. 591.—VALENTINE'S IRRIGATING APPARATUS.

The **treatment of chordee** consists in securing an evacuation of the bowels just before retiring, of requiring the patient to abstain from late meals and to sleep on a hard mattress with light bed-covering. The bromids should be given freely in carbonic acid water during the day; on retiring a double dose should be given alone or with 15 drops of tincture of belladonna. A suppository containing one grain of opium and three grains of camphor is frequently useful. Finally, if the symptoms persist in spite of these measures, the application of half a dozen leeches to the perineum, the patient maintaining the recumbent position with hips elevated, will be of service. The persistent recurrence of the phenomena of chordee tends to aggravate the inflammation and increase the liability to stricture.

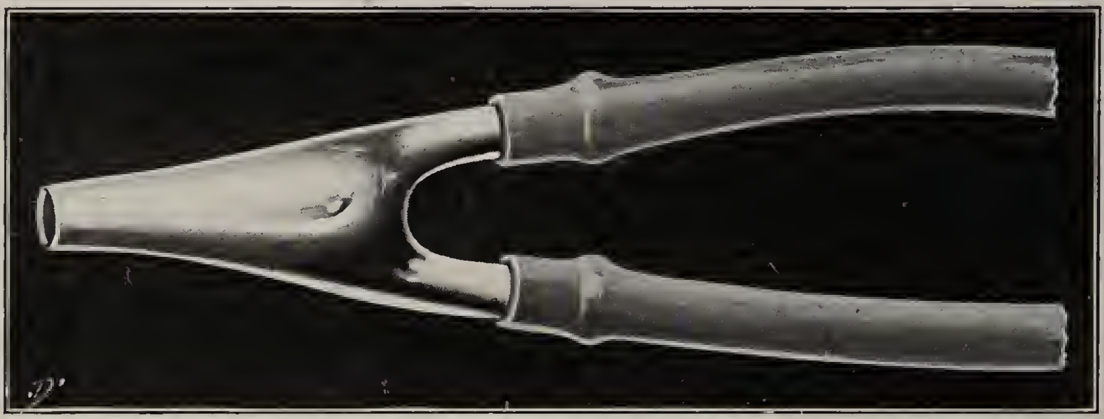

Fig. 592.—Chetwood's Two-way Urethral Nozzle.

Traumatic Stricture.—All acquired organic strictures of the urethra arising from causes other than gonorrhea are included in this class. **Blows, or falls on the perineum,** such as are received when the patient falls astride a hard resistant body, and fracture of the pelvis with laceration of the urethra, are the most common causes of traumatic stricture. It is sometimes produced by **rough instrumentation** and occasionally results from some of the **methods of treating former contractions,** such as cauterization and electrolysis, as well as incision and excision. **Foreign bodies** arrested in the urethra may give rise, through ulceration, to traumatic stricture. **Injuries received during coitus,** from so-called "false movements," produce traumatic stricture; the erected organ is completely withdrawn and then thrust violently against the woman's external parts, producing the so-called fracture of the penis (subcutaneous rupture of the erectile tissue, see page 255). **"Breaking the chordee,"** *i. e.*, violently straightening the organ during chordee, will cause it. **Intra-urethral chancres and chancroids** will produce stricture. **Injections** are probably not so frequent a cause of stricture as was formerly supposed.

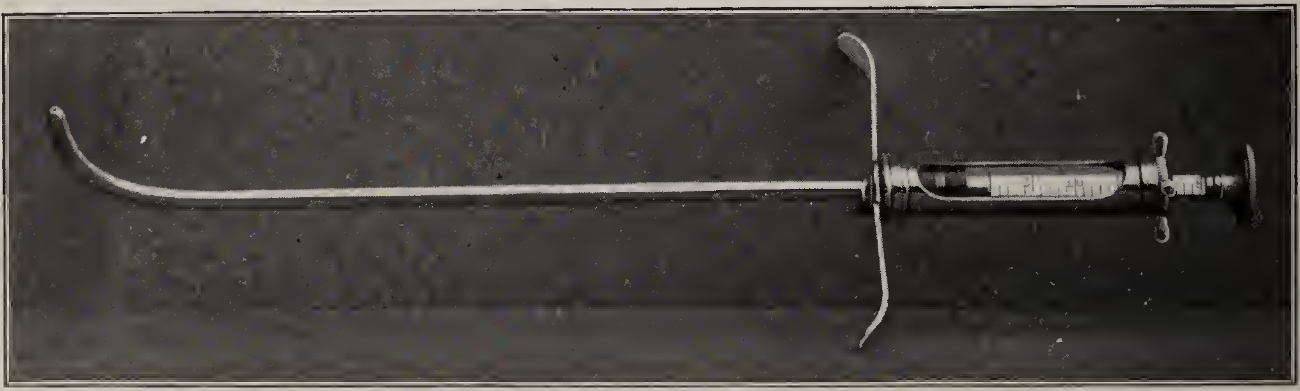

Fig. 593.—Keyes's Instillation Syringe.

The **location** of traumatic stricture varies with the cause. In cases of blows and falls the stricture is usually situated at the perineal or perineobulbar portion. In fracture of the pelvis and laceration of the urethra the stenosis occurs in the membranous portion. The stricture following injury during coitus is usually situated at the root of the organ. After rupture of a chordee the contraction will usually be found in the penile urethra. When the stricture originates in a chancre or chancroid or is due to the ulceration produced by a foreign body, it is found, as a rule, near the meatus or in the fossa navicularis.

Traumatic strictures are almost always single and are decidedly cicatricial in character. These points, taken in connection with the situation of the stenosis and the history of the alleged injury, will be of value in establishing the differential diagnosis under circumstances of medicolegal contention.

The Complications and Sequels of Gonorrheal Urethritis, Balanitis, and Posthitis.—These complications are usually caused by neglect of cleanliness and consist of an inflammation of the surface of the glans penis and of the mucous membrane lining the prepuce. In a mixed infection the chancrous erosion may be mistaken for a balanitis. An extension of the inflammation from the glans penis to the lining of the prepuce will give rise to a **balanoposthitis.** Inflammatory involvement of the loose connective tissue of the prepuce in its turn may prevent retraction of the foreskin and produce **phimosis.** Or, if the swelling take place while the foreskin is retracted, the opposite and more dangerous condition of **paraphimosis** will be present.

The above complications make their appearance during the first week of the disease. Later on occur the following, these frequently proving of greater surgical interest than the disease itself.

Lymphangitis takes place as a result of infection with pyogenic microorganisms in uncleanly patients. The lymphatics of the dorsum of the penis are most frequently affected. **Gonorrheal bubo,** affecting one or more of the superficial groups of glands lying below Poupart's ligament and appearing as a small painful tumor, may occur with or without a preceding lymphadenitis.

Gonorrheal Epididymitis.—This originates from propagation of the infection to the epididymis through the medium of the ejaculatory ducts and the vasa deferentia, rather than by metastasis, as suggested by Vidal. These intervening structures rarely become inflamed, though the slight pains and tenderness along the cord have been ascribed to a **deferenitis** (Gosselin). The slight vascularity of the vas deferens renders this but slightly susceptible to infectious inflammation. The disease may occur during the acute early stages or in the course of a persistent gleet. The spermatozoa may disappear from the semen as a result of double epididymitis. A chronic inflammation may supervene on an acute attack or the epididymitis may be subacute or chronic from the commencement.

Cowperitis.—Inflammation of Cowper's glands is of somewhat rare occurrence. It may result in abscess of the perineum; the fistulous openings communicate with the glands and discharge a thin mucuslike fluid. Accumulation of secretion may give rise to small globular swellings, which may be emptied by pressure applied by the finger in the rectum.

Gonorrheal Cystitis.—Cystitis is an infrequent complication of gonorrheal urethritis. It arises from extension of inflammation to the internal urethral orifice and thence to the mucous membrane of the bladder. The absence of the vascularity of the prostatic portion of the urethra does not favor extension beyond this point. Moderate fever, tenderness in the hypogastrium, dull pain and sense of weight, followed by neutral or alkaline urine and the expulsion of mucopurulent material at the end of the act of urination, are characteristic symptoms, particularly the last named. The application of the three-glass urine test will serve to differentiate the condition from simple posterior urethritis, the last of the urine passed in the third glass containing the mucoid material.

Vesiculitis (Spermatocystitis).—The seminal vesicles and their excretory ducts become occasionally inflamed as a complication of acute urethritis. The symptoms are (1) a sense of weight and bearing-down pains about the perineum and rectum, increased by defecation; (2) **priapism** and other evidences of sexual hyperesthesia. Rectal digital examination shows the seminal vesicles to be inflamed, enlarged, and tender. They appear as elongated fusiform bodies on the posterior bladder wall, just above the prostate.

The **diagnosis** of vesiculitis is made by "milking the ducts," *i. e.*, forcing their contents into the urethra by the finger in the rectum, from which it is washed by the urine into a glass. The urethra should be washed out beforehand by passing a portion of urine. This is passed into a glass; the "milking" is then done, and another portion of urine is passed in a second glass. Finally, the bladder is emptied. The three glasses are then compared. The first represents the washings from the urethra, the second the expressed contents from the seminal vesicles, and the third the urine as contained in the bladder. If vesiculitis is present, the urine in the second glass will contain more pus than the urine in the third, and in addition dead spermatozoa will be found. The latter depend on the destructive effects of the pus on the spermatic elements, which may finally lead to temporary impotence.

The Treatment of the Complications of Gonorrhea.—**Balanitis.**—The surface of the glans penis is to be washed three or four times daily with simple warm water and dusted with equal parts of boric acid and oxid of zinc, to which may be added one-fourth part of powdered opium. If ulceration is present, iodoform is to be used. The parts must be kept as dry as possible by strips of absorbent lint or bits of absorbent cotton, placed between the glans and the foreskin. When the prepuce is involved (**balanoposthitis**), a lead and opium wash is useful. A piece of lint with a hole in it sufficiently large to slip over the glans and rest around the corona is kept in position by sliding the foreskin over it. This dressing is kept moistened with either the lead and opium wash, the opium and carbolic wash, or the sublimate solution, 1 : 10,000 in a 2 per cent solution of acetate of aluminum.

Phimosis.—The lead and opium lotion or the lead and carbolic lotion will usually suffice to correct this complication. At the same time thorough cleanliness must be practised, cleansing fluids being forced beneath the prepuce, followed by the lotion employed in the same manner as in balanoposthitis, until the glans can be exposed. Circumcision, or splitting the foreskin on the dorsum, should be postponed, if possible, till a later period.

Paraphimosis.—The treatment of paraphimosis consists in removing the constriction by restoring the prepuce to its normal position. There is usually considerable edema of the parts, which can be reduced by bathing with cold water, compression by means of a bandage, or by puncture, if the case is seen sufficiently early. Reduction should be then effected by grasping the body of the penis and encircling it with the thumb and index-finger of one hand, covered with dry gauze to prevent slipping; with the other the glans is compressed and pushed in the preputial orifice (Fig. 594). Or, the index-fingers of both hands are placed on the dorsum, with the middle fingers opposite, while both thumbs are employed to compress the glans gradually and force it backward, the fingers at the same time bringing forward the foreskin (Fig. 595). Compression of the glans and parts in front of the constriction may also be effected by the application of a very narrow rubber bandage, or the successive turns of a round elastic ligature applied over a strip of wet lint. The constriction being identified, a grooved director is to be placed beneath the same, the narrow bandage or elastic ligature rapidly removed, and the reduction accomplished before the glans can refill. If these measures fail, the patient is directed to hold the penis in hot water every two hours for fifteen minutes and then to lie down and keep it elevated. After twenty-four hours another attempt at reduction may be made. In some cases compression by means of adhesive plaster, kept up overnight, will so far reduce the swelling as to permit reduction in the morning. If the prepuce cannot be replaced in this manner, or if dangerous complications threaten, the constriction must be divided. To do this, pass a probe-pointed bistoury flatwise under the preputial orifice and beneath the constricting band in the first furrow behind the normal coronal sulcus (Fig. 583, 3), and between the two swollen and edematous folds, bring it to the median line on the dorsum and cut directly upward. Or, if the constricting band can be thoroughly identified, it may be incised from without. In old cases any thickened tissues may be removed by means of two elliptic incisions on each side, the edges of the wound may be sutured (Mauriac).

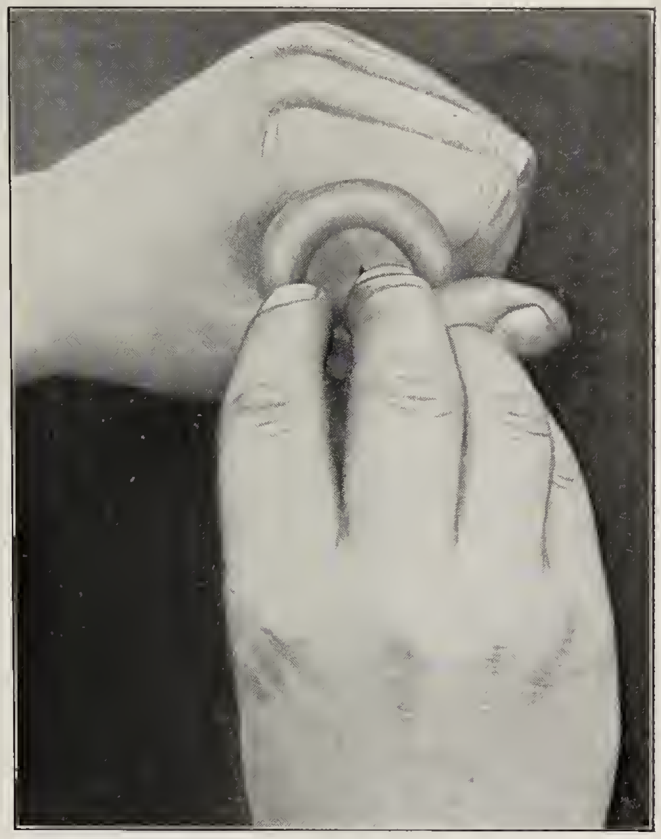

Fig. 594.—Reduction of Paraphimosis. First Method.

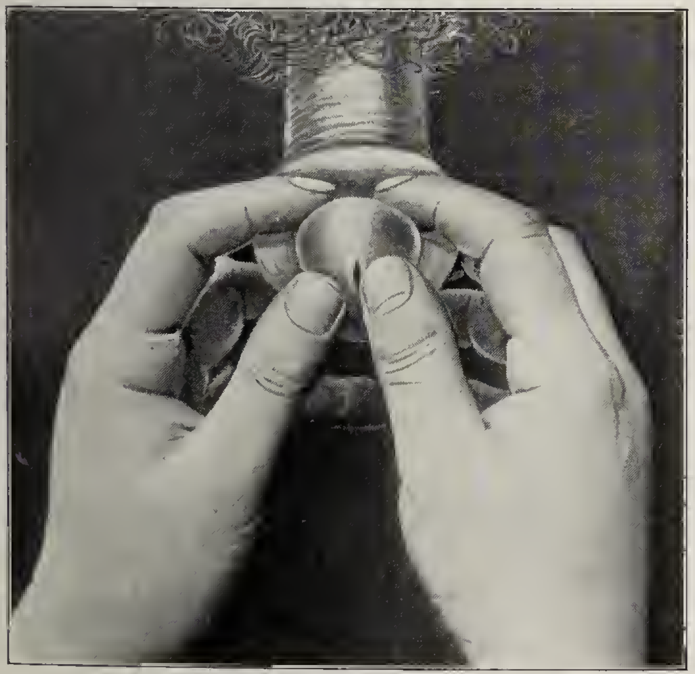

Fig. 595.—Reduction of Paraphimosis. Second Method.

Epididymitis.—The treatment consists in rest in bed and the application of an ice-bag over lint wet with the carbolic and opium, or the lead and opium lotion, the parts being supported on a pillow placed between the thighs at the same time. Applications of the **actual cautery** (Halsted), the skin overlying the inflamed organ being lightly touched with the white-hot point, and this followed by the application of iodoform ointment spread on lint and held in place by a suspensory bandage, are said to hasten the cure and permit the patient to be up and about. Later on the dry poultice, consisting of cotton-wool covered with thin rubber tissue and supported by a suspensory, will be useful. When properly done, **strapping the testicle** serves a good purpose in hastening the final cure. The method of compression by means of a piece of thin rubber bandage held in place by adhesive plaster (Chetwood) is efficient (Fig. 570). All local treatment for urethritis must be suspended while an attack of epididymitis is in progress. In cases of **recurrent epididymitis** in which all other measures fail and the disease persistently returns, vasectomy may be performed (Chetwood). The vas deferens is divided through a small incision near the raphe and each end ligated and dropped back.

Cowperitis is best treated by rest in bed, laxatives, hot hip baths, and the frequent application of hot compresses or poultices and incision as soon as the occurrence of suppuration can be determined. The suppurating foci are carefully cleansed and drained by means of iodoform gauze. Should a fistula persist after the usual treatment by hydrogen dioxid and stimulating applications, the fistulous track, together with the remains of the gland, is to be dissected out.

Gonorrheal Cystitis.—The administration of diuretics, to which boric acid is added, in 10-grain doses three or four times a day in order to sterilize the urine, the use of oil of sandalwood in full doses, and rest in bed constitute the general measures of treatment. Suppositories of opium and hyoscyamus to relieve pain and vesical tenesmus are indicated. As soon as a catheter can be introduced the bladder should be gently irrigated with a simple sterilized normal salt solution, then with a saturated solution of boric acid, and finally the boric acid solution with 2 per cent of salicylic acid added. After the removal of the pus and other debris by these means, the bladder being empty, instillations into the bladder of a solution of nitrate of silver, 1 : 5000 to 1 : 1000, are to be used and repeated daily if necessary. Twenty drops are to be introduced at each sitting. Daily irrigations with permanganate of potash solution (from 1 : 6000 to 1 : 4000) are sometimes sufficient in mild cases.

Vesiculitis.—Hot rectal douches, with rest in bed, and opium suppositories to allay pain are indicated. Refrigeration of the parts by means of a double-current catheter without an eye (the psychrophore), through which a cold stream of water is passed, is useful (Fenger). Bromids in carbonic acid water, or camphor, are useful in allaying sexual hyperesthesia. General tonics, sea bathing, etc., are used in chronic cases.

Chronic Urethritis.—Acute gonorrheal urethritis may terminate in a chronic inflammatory condition (**gleet**). This may be due to (1) the tendency of the infection to lurk in the tissues of the urethra, the anatomic environment favoring this; (2) the too early relinquishment of treatment; (3) sexual and alcoholic indulgences before recovery; (4) the use of too strong remedies or the too prolonged use of mild local remedies. The anterior, bulbous, and posterior portions of the urethra may be involved either singly or conjointly. The pathologic changes present as a result of the gonorrheal process include catarrhal inflammation, with exudative inflammation in the submucous connective tissue, which, if persistent, may finally inflict permanent damage on the urethra. Thickened areas, granular and warty patches, polypoid growths, erosions, and ulcers are present and may be demonstrated by the urethroscope. In **chronic anterior urethritis** the disease is limited to the mucous membrane of the urethra and is usually mild and uncomplicated. Acute gonorrheal inflammation of the bulbous urethra, owing to the rich vascular supply and the relaxed state of the tissues, shows a marked tendency to become chronic and persistent (Taylor).

Chronic Posterior Urethritis.—This is frequently combined with inflammation of the bulbous portion. There may likewise coexist chronic catarrhal prostatitis, chronic inflammation of the verumontanum, and involvement of the seminal vesicles in the gonorrheal infection (see page 278).

Symptoms of Chronic Urethritis.—The characteristic symptom of chronic anterior urethritis is the accumulation of mucopurulent material in the anterior urethra and its escape by either gravity or expression, in the morning. This is usually small in quantity; oftentimes it is only just sufficient to glue the lips of the meatus together. There may be no discharge except that which is washed away with the urine in the form of threads (tripper-faden); these latter consist of a small amount of purulent secretion and urethral epithelium, too slight to appear as a discharge, which is forced from the granular patches and rolled in the shape of threads by the stream of urine. The heavier of these little cylindric masses consist mostly of pus, sink to the bottom of the glass, and on microscopic examination may be found to contain gonococci. The lighter ones consist mainly of epithelium; they float about in the urine, are free from gonococci, and their presence indicates a subsidence of the infection. The discharge may be of a greenish-white color, or glycerin-like. As a rule, the larger it is in amount, the more pronounced the color. The discharge from the meatus may finally cease, in which case, before the patient is discharged as cured, the urine should be examined for the tripper-faden.

In chronic urethritis at the bulb the discharge may not escape from the meatus but simply reach this point and glue together the lips, escaping from time to time during the day as a decided drop.

Chronic posterior urethritis, in the average case, is characterized by a more or less frequent desire to urinate, with some uneasiness at the end of the act. These may be the only symptoms. The uneasiness sometimes amounts to a decided pain, which, however, passes away quickly. Or, there may be no disturbances of urination, the patient complaining only of a dull ache in the prostatic region and rectum, with vague uneasy sensations or pain in the pubic region, along the spermatic cord, or in the testes. Neuralgic pains may radiate to the lumbar and inguinal regions and to the thighs. In more severe cases the pain is spasmodic in character; it may occur only at the end of the act or the latter may be interrupted by its occurrence.

These conditions may alternate from day to day and in some cases are absent almost entirely for a day or two at a time. They are usually called into existence by coitus and are aggravated by constipation. Normal sexual sensations are lessened or abrogated altogether. Premature emission during intercourse is common, and nocturnal pollutions, which are sometimes blood-stained from hyperemia of the ejaculatory ducts, are present in some cases. Such patients suffer mentally, and this suffering is aggravated by the escape of prostatic and seminal secretions during defecation when constipation exists. Patients belonging to this class are weak, nervous, and apprehensive;

they complain of digestive disturbances and are sometimes decidedly neurasthenic.

The **diagnosis** is established by the presence of the foregoing symptoms, and, in the case of the anterior and bulbous portions of the urethra, by the results of urethroscopic examination (see page 290). Deeply congested and thickened conditions of the mucous membrane appear in areas more or less extensive and pus of different degrees of consistency may be seen. In the bulbous portion particularly small projections or eminences may appear (**granular urethritis**). A more pronounced form of the latter may be present (**papillomatous urethritis**). The latter may appear as minute raspberry-like masses, scattered from within an inch of the meatus to the bulb. They are often the cause of the slight bleeding following the most careful introduction of a steel sound or the passage of a soft catheter. Patches of erosion are present where the epithelium alone has been lost; ulceration is marked by a more distinct loss of substance.

Examination of the morning urine shows this to be cloudy and the characteristic long threads to be present. Gonococci may or may not be present.

At the first examination instrumentation should be carefully employed and preferably avoided altogether, the main reliance being placed on the history and the symptoms present and examination of the urine.

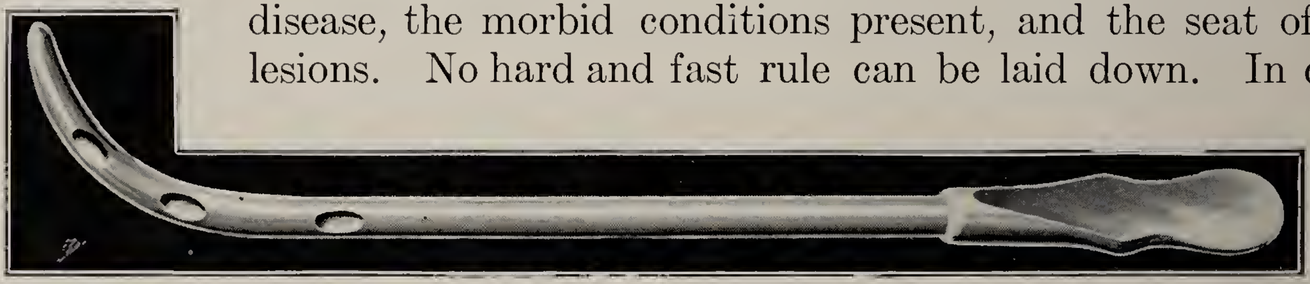

Fig. 596.—Cupped Sound.

Treatment.—This will depend on the duration of the disease, the morbid conditions present, and the seat of the lesions. No hard and fast rule can be laid down. In cases in which the morning drop and some discharge reappear only on sexual intercourse and alcoholic indulgences, irrigation with a warm 1 : 5000 solution of alum and sulfate of zinc is useful at first. As the efficacy of this wears off, hot irrigations of 1 : 1000 to 1 : 2000 solutions of permanganate of potash may be substituted. Finally, irrigations of nitrate of silver (1 : 16,000 to 1 : 8000) are to be used. These will usually prove efficacious if carefully and judiciously employed. The soft-rubber reflux catheter, when employed in connection with a 2- or 4-ounce hard-rubber piston syringe for this purpose, is useful. The use of sounds should always be avoided in these cases in the beginning. In unusually obstinate cases the disease is generally limited to the bulb, when direct applications may be made; a few drops of a stronger solution of nitrate of silver (from 1 : 2000 to 1 : 250) should be employed through a soft-rubber catheter, introduced to about $6\frac{1}{2}$ inches, or to the sinus of the bulb, by means of a small glass syringe graduated in drops. Or, the application of a still stronger solution (20 to 40 grains to the ounce of water) may be made by means of a cotton applicator through the urethroscopic tube.

Obstinate cases involving chronic follicular inflammation, urethral thickenings, erosions, ulcerations, or granulations in the pendulous urethra, are best treated by direct applications of the stronger nitrate of silver solutions through the urethroscopic tube. In posterior urethritis careful instillations of the stronger nitrate of silver solutions by means of the soft-rubber catheter and the small graduated syringe are to be employed, and steel sounds, commencing with No. 22 (F.) and gradually increasing, should be passed once or twice a week. The cupped sound (Fig. 596) is sometimes useful. The recesses are to be filled with an ointment consisting of nitrate of silver 1 part and lanolin and white wax 100 parts (Taylor), and the sound left in place for five minutes.

For the treatment of the complications of gonorrheal urethritis, see p. 278.

Organic Stricture of the Urethra.—Stricture is the most common complication and sequel of gonorrheal urethritis. **Stricture from simple swelling** occurs in connection with superficial inflammation of the mucous membrane; the epithelium is destroyed and the exposed connective tissue becomes the site of granulations. These may last for months and finally disappear. **Stricture from cicatricial contraction** is the result of invasion of the deeper layers of the connective tissue. Involvement of the para-urethral connective tissue leads to the formation of masses of connective tissue, which may be felt externally. As a consequence of the lessened caliber of the urethra the patient notices a **diminution of the size of the stream of urine**; this may assume a spiral shape. These disturbances of the act of urination may increase until retention takes place.

Dilatation of the urethra behind the stricture occurs early. Obstruction to the passage of urine favors irritation at the point of dilatation, and may even become a new source of inflammation. The stricture itself takes part in the inflammatory process, and the stenosis is thus increased. Extension of suppurative inflammation from the mucous membrane (folliculitis) leads to infection of the surrounding connective tissue and **para-urethral abscess** results. Infection may also follow injuries that are the result of instrumentation. Spontaneous opening or incision of these gives exit to a mixture of pus and urine and a urethral fistula at the perineum usually results. Progressive urinary infiltration leads to the formation of several fistulous tracks, some of which may extend above the symphysis pubis and into the abdominal wall. These urethral fistulas are almost entirely confined to strictures in the bulbous and membranous portions, where, in fact, the great majority of strictures and those of the worst character are found. **Cystitis** may follow the occurrence of stricture. This form of cystitis is more dangerous than the ordinary forms of bladder inflammation owing to the difficulties in making local applications as long as the stricture exists. It easily assumes a purulent character, death resulting from pyemic infection, pyelonephritis, or more rarely from phlegmonous inflammation within the lesser pelvis, erysipelas infection of the tracks of urethral fistulas, or **rupture** of the bladder.

The length of the stricture may vary from a mere linear septum of connective tissue projecting into the canal to an indurated mass extending for half an inch or more. The strictures may vary in caliber from those which will admit an instrument but slightly smaller than the individual's normal size (**strictures of large caliber,** Otis) to those which will not permit the introduction of any instrument whatever.

Gonorrheal stricture occurs fourteen times as frequently as traumatic strictures.

Diagnosis of Stricture.—Aside from the symptoms, the diagnosis of stricture is to be made by instrumental examination. The olive-tipped bougie or *bougie à boule* is the best of the instruments in ordinary use for this purpose. The urethrometer of Otis (Fig. 597) is a very ingenious instrument, but it is quite complicated and liable to get out of order easily. The olive-tipped instrument produces less friction in its passage than a straight one; hence, when arrested it communicates a more decided sense of resistance to the touch. After passing through the stricture, on withdrawal its bulbous shoulder encounters the proximal limit of the stricture and thus the length of the latter can be ascertained. An examination under an anesthetic may be necessary in sensitive patients, in whom **spasm of the compressor urethrae may simulate a stricture.** An enlarged prostate may also be a source of error.

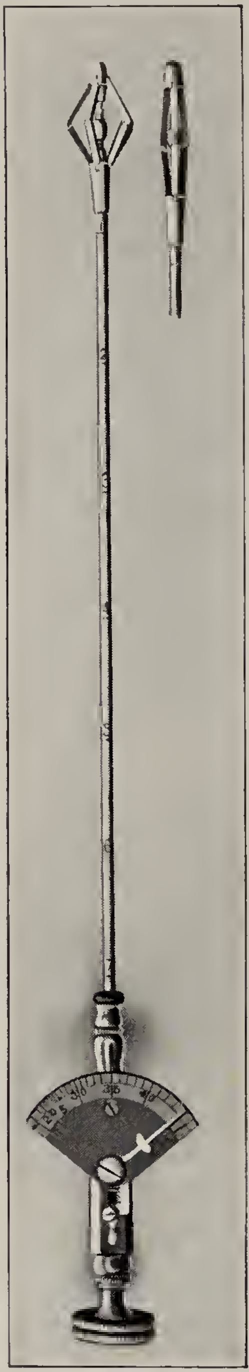

Fig. 597.—Otis's Urethrometer.

Urethroscopy may assist in the diagnosis in cicatricial stricture by revealing the whitish shining color of the tissues, and in stricture from simple swelling by showing the dark color of the proliferating granulations contrasted with the normal pink mucous membrane.

Treatment of Stricture of the Urethra.—Gradual Dilatation.—Only those strictures which will allow the passage of an instrument (**permeable strictures**) admit of treatment by this method. The procedure is of greater service in recent stenosis or **strictures due to swelling** than in old cicatricial narrowings. The pressure of the smooth metal exerts a beneficial effect on the granulations, insures free passage for the urine, and lessens the tendency to cicatricial contraction. Where a complicating cystitis exists and irrigation of the bladder is indicated, a full-sized, two-way metal catheter, employed both as a sound and for irrigating purposes, may be advantageously substituted for the dilating sound.

Benefit may also be derived from this method of treatment in cicatricial strictures. From the instrument which may be passed readily, advances may be made at varying intervals, according to the sensitiveness of the patient, until the normal caliber is reached. Some patients will bear the daily passage of a sound, while others require several days of rest between the séances.

In the hands of those unaccustomed to the manipulation, metal sounds may become a source of great danger. **Elastic bougies** find their way with great certainty through the stricture, and are much less likely to produce false passages. Very desirable instruments of English, French, and American manufacture are now obtainable at the instrument shops. With these the patient may be trusted, after proper instruction, to pass the instruments himself.

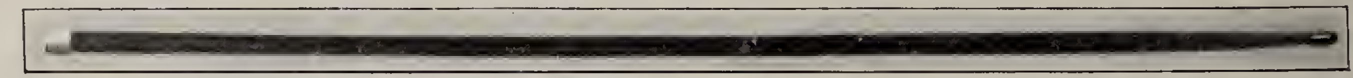

Fig. 598.—Olivary Bougie.

The preliminary introduction, by means of a suitable glass syringe, of a dram of oil, sterilized by being previously boiled, will be of assistance. One part of castor oil to two parts of cottonseed oil makes a good lubricant. In very sensitive patients the injection of the oil may be preceded by a half dram of a 4 per cent solution of muriate of cocain.

In so-called **tight strictures** or strictures of small caliber in which the method of gradual dilatation is determined on, these admitting only a filiform whalebone bougie, tunneled sounds (Fig. 599) will be of service. The smallest of a set of these is threaded on the filiform after introduction, and, with the latter as a guide, the metal instrument is conducted into the bladder. Successively larger sizes are then introduced. Where difficulty is experienced in locating the opening in the stricture with the filiform bougie, a number of these may be introduced, one after the other, until either the entire urethra in front of the stricture is filled, or one of the filiforms passes into the bladder. As soon as olivary bougies can be introduced these should be used up to 20 F., after which sounds up to from 30 to 35 F. are to be employed. The dilatation so gained is to be kept up by the surgeon until the passage of the sound is easy. Gleety discharge should receive appropriate treatment. As a rule, however, it will be found difficult to carry on the treatment by gradual dilatation in strictures of small caliber. As soon as the dilating urethrotome can be introduced those situated in the penile urethra should be submitted to **internal urethrotomy** (see below). Those deeply situated are best treated by **external urethrotomy** when permeable and by **perineal section** when impermeable.

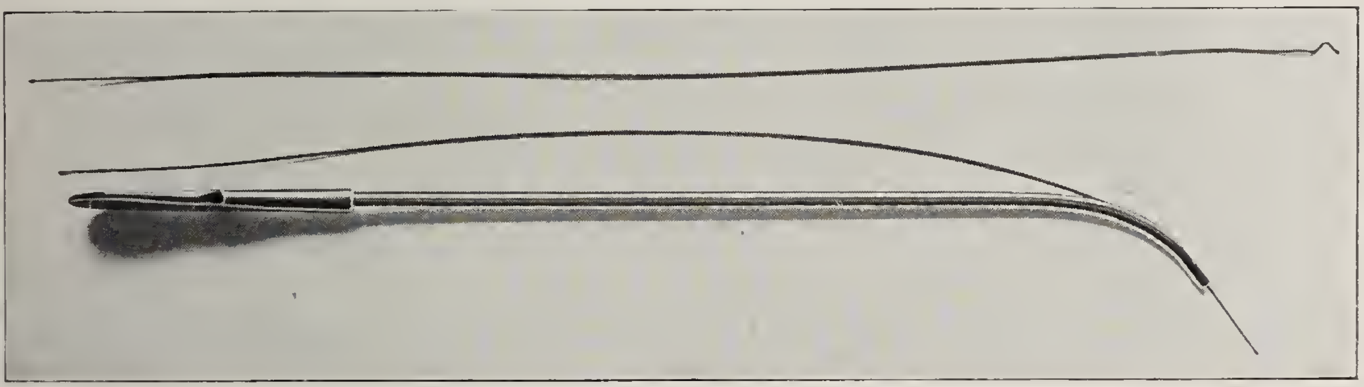

Fig. 599.—Filiform Bougie and Tunneled Sound.

Strictures in the penile urethra may usually be pronounced cured if recontraction does not take place in three months. Those in the bulb tend to recontract and must be dilated at intervals of from a fortnight to a month. This can usually be done by the patient himself after proper instruction.

Resection of the Urethra (Urethrectomy).—This operation has been applied for long, tight, and nodular strictures, and those para-urethral fibrous indurations encircling the urethra in the perineum in which previous operations have failed (Poncet). The gap may be filled by implantation of the inner layer of the prepuce (Keyes). Or, the fibrous band may be dissected away and the edges of the gap thus formed sutured over a catheter with catgut (Mayo Robson). In some cases the divided ends may be approximated without tension by splitting the scrotum.

Internal Urethrotomy.—In this method the urethra is divided from within by means of a blade concealed in the groove of a staff, which is projected so as to cut either on the roof or on the floor of the canal. A blunt tenotome with convex cutting-edge is all that is required in operations on the meatus or within the first inch of the urethra. The operation finds its best field of usefulness in cases of well-defined and uncomplicated stringlike strictures the result of deposits of cicatricial tissue in the mucosa and submucosa and in the para-urethral connective tissue.

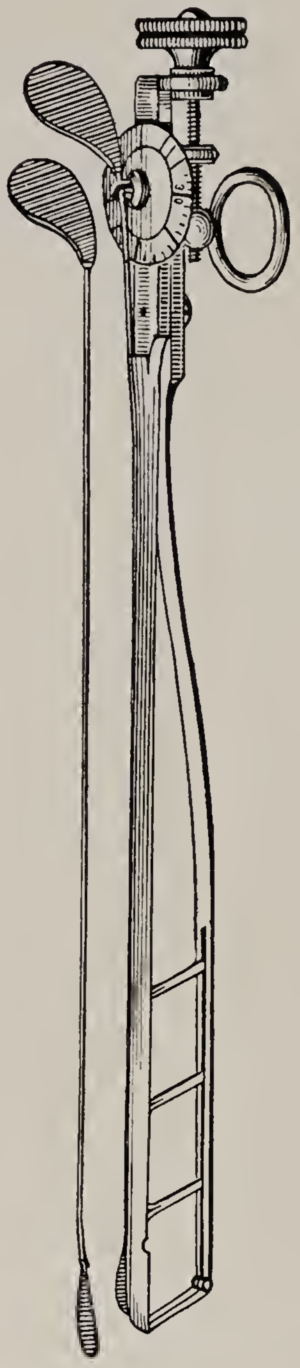
FIG. 600.—DILATING URETHROTOME OF OTIS.

The **contraindications** are the following: (1) flattened-out and indurated strictures with ill-defined margins, extending over a considerable surface; (2) localized swellings in which the obstruction is shown by the urethroscope to be mainly due to congestion; (3) the presence of urethritis.

The dilating urethrotome of Otis is intended to cut from behind forward and at the same time so to dilate the strictured portion as to insure its complete division (Fig. 600). The stricture is first located with the urethrometer or *bougie à boule,* the instrument passed beyond the stricture and the screw at the handle turned, the instrument being thus dilated up to and somewhat beyond the normal caliber. The blade is then withdrawn distad to the stricture and thus is made to cut through the cicatricial tissue. For strictures too small to admit the passage of an Otis instrument the urethrotome of Maisonneuve may be used (Fig. 601).

The patient should be prepared for internal urethrotomy by being kept in bed for a day or two beforehand, the bowels being freely opened by salines. Seven and a half grain doses of urotropin are given three times daily both before the operation and during convalescence.

The operation itself should be conducted with every aseptic precaution, including preliminary boric acid irrigation of the urethra with a return flow irrigating nozzle, and sterilization of all instruments by boiling them in a 1 per cent solution of sodium carbonate.

The **after-treatment** consists in emptying the bladder every six to eight hours by means of the catheter, in irrigating both the bladder and the urethra

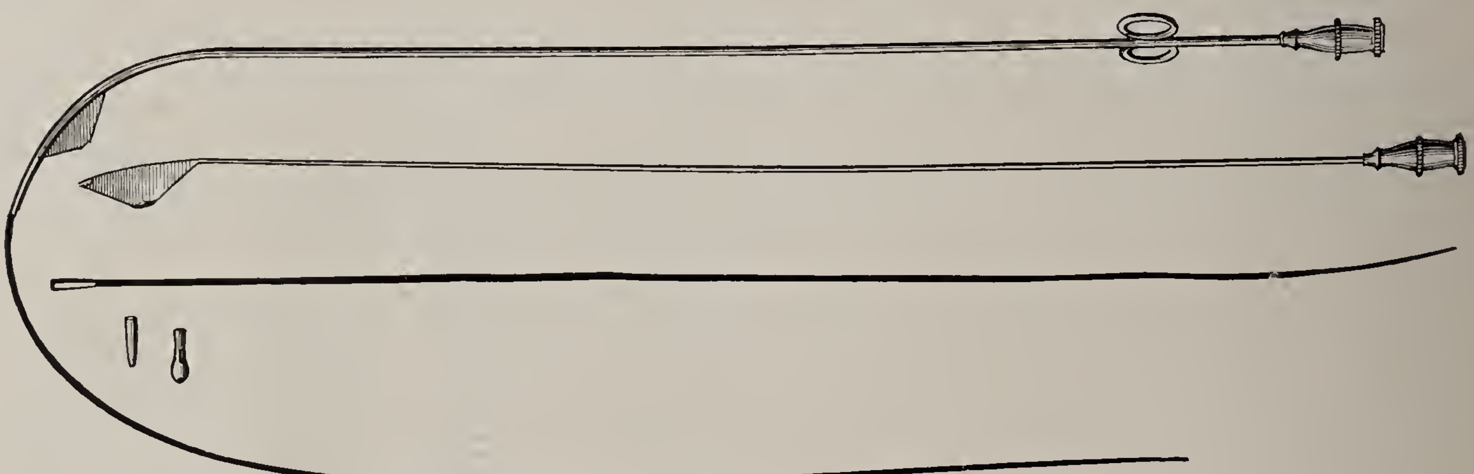
FIG. 601.—URETHROTOME OF MAISONNEUVE.

with boric acid solution each time this is done, and in administering urotropin. If the urine is acid, and hence sterile, irrigation of the bladder is unnecessary. A full-sized sound is passed at the end of the second day and the further treatment is continued as in the treatment by gradual dilatation. The patency of the canal must be maintained for weeks and perhaps months, and occasional examination made, even after a year has elapsed, in order to guard against recurrence.

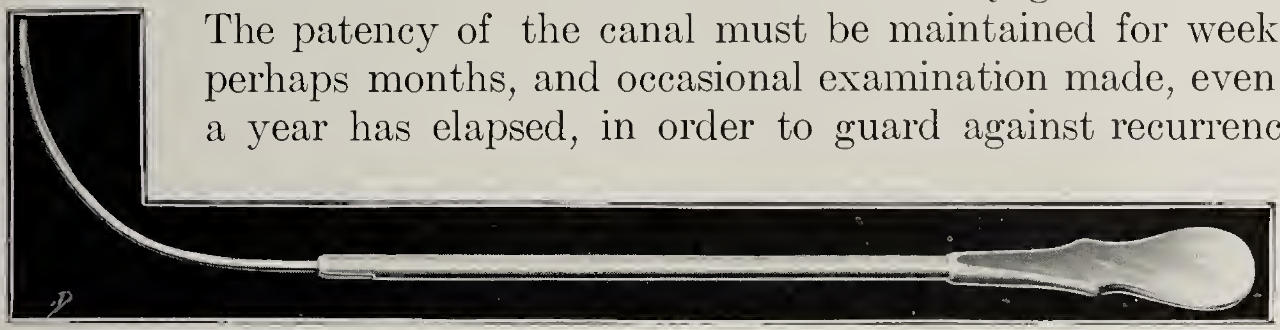

Fig. 602.—Syme's Staff.

External Urethrotomy.—This term is applied to the operation of incising the urethra from without on a guide. Though usually applied to strictures behind the bulb, it differs from perineal section in that the latter is performed without a guide. Permeable strictures in the locality named are subjected to external urethrotomy, while impermeable strictures are subjected to perineal section. In **Syme's operation** a grooved staff (Fig. 602) is used with a narrow terminal portion, which passes through the stricture when the instrument is in position. In very tight strictures it will be found impossible to pass this instrument, in which case a filiform whalebone bougie is introduced, and on this a tunneled sound, or in case retention is present, a tunneled catheter is passed (Fig. 603). In addition to the staff guide or tunneled catheter, a scalpel, a probe, a Teale gorget (Fig. 604) or a broad-grooved director will be required.

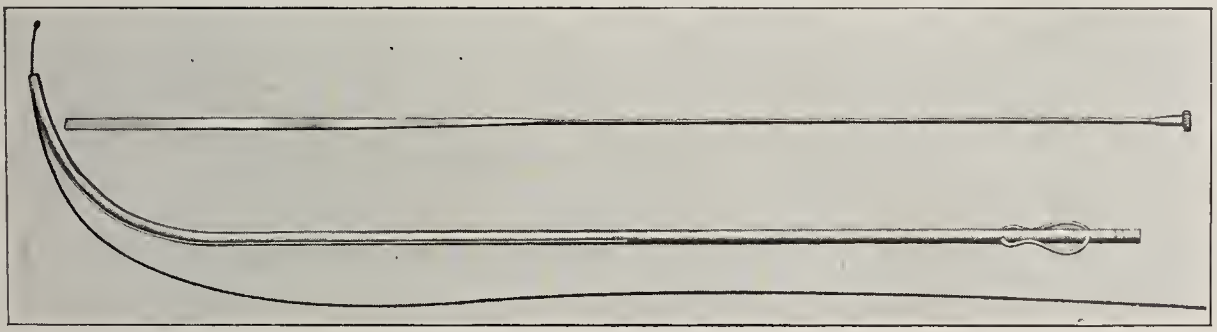

Fig. 603.—Tunneled Catheter.

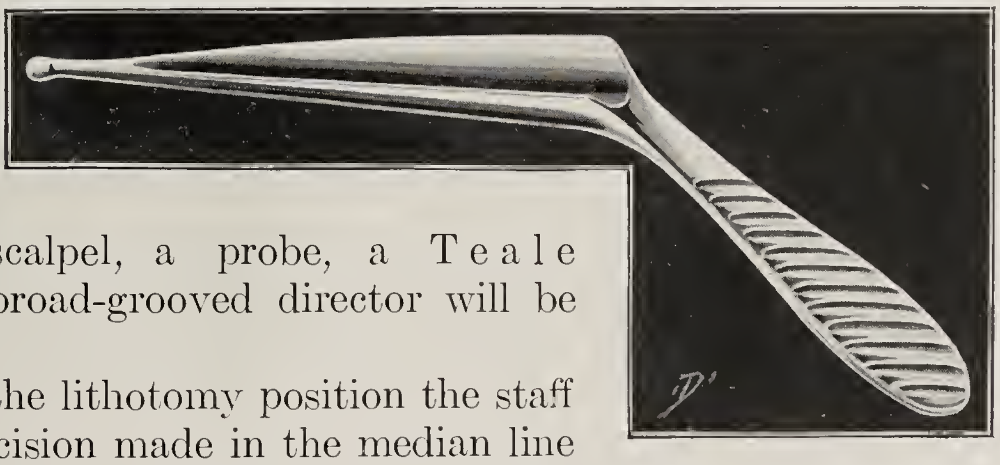

Fig. 604.—Teale's Gorget.

With the patient in the lithotomy position the staff is introduced and an incision made in the median line of the perineum. If Syme's staff is used, the point of the knife is so directed as to hit the shoulder portion, which rests on the face of the stricture. If the filiform guide and tunneled staff are employed, the distal limit of the stricture must be ascertained subsequently to opening the urethra.

After opening the urethra, the point of a narrow knife or the straight bistoury

(Fig. 71) is engaged in the groove of the staff and passed steadily onward toward the neck of the bladder, dividing the stricture in its passage. The Teale gorget is now introduced, the groove on the convexity of the staff serving for a guide, in which its extremity rests, and the staff is withdrawn. A full-sized velvet-eyed soft-rubber catheter is passed along the gorget, the latter removed, and the catheter secured in position by tapes attached to a safety-pin passed through the wall of the instrument. Four tapes are employed, two passing in front and secured to loops of adhesive plaster just above the anterior superior spinous process of the ilium, the other two passing behind and similarly secured in the loin. When prolonged drainage of the bladder is necessary, as, for instance, in certain cases of intractable cystitis where the "*boutonnière*" operation is performed for the purpose of giving rest to the bladder, as well as in certain cases of prostatic hypertrophy, I have employed with advantage the device figured in the cut (Fig. 605). It consists of a silver tube, with movable collar, about an inch and a quarter long. The *outside* diameter of the tube corresponds to the diameter of the soft-rubber catheter to be used. The end of the catheter is trimmed to an angle so as to permit the easy passage of this portion of the instrument through the silver tube. When this is accomplished, the two ends of the catheter are grasped and the latter elongated by stretching. This likewise reduces its outside diameter sufficiently to permit the placing of the silver tube at any desired point, where it will be securely held by the pressure of the rubber when the catheter is allowed to regain its former length and diameter. The tapes are secured in the slits in the collar.

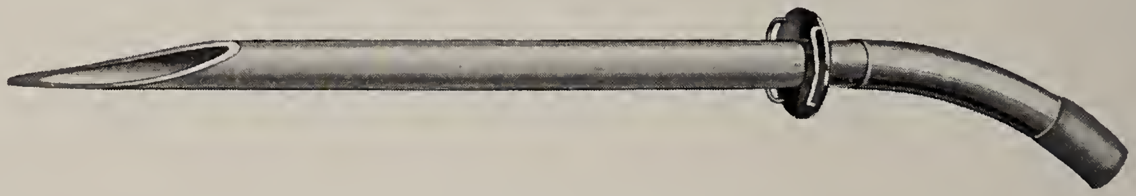

Fig. 605.—Perineal Drainage-tube.

The distal end of the rubber drainage-tube is shown cut off at an angle to facilitate its passage through the curved silver cannula, which occupies the perineum, only the proximal portion of the rubber tube resting in the bladder.

Choice of Operation for Stricture of the Urethra.—All **permeable strictures** that are easily dilatable may, as a rule, be subjected to **gradual dilatation.** Those that prove to be resilient and retract between the séances, as well as those which have been apparently cured, but in which **recurrence** takes place, if they are situated in front of the bulb should be subjected to **internal urethrotomy,** and if situated behind the bulb to **external urethrotomy.** Very sensitive individuals who cannot bear the frequent repetition of passing the sound should be exempt from the rule, as well as those who suffer from urethral chills and fever after instrumentation. With the use of cocain at the first few sittings the sensitiveness of the urethra will gradually disappear in the great majority of cases; unless some idiosyncrasy on the part of the individual patient prevents the employment of this drug for local anesthesia, the cases in which gradual dilatation, otherwise indicated, will be abandoned on account of extreme sensitiveness of the urethra will be comparatively few.

The existence of **cystitis** is a contraindication to the employment of gradual dilatation, on account of the risk of setting up a pyelonephritis during the treatment. Here prompt access to the bladder with a full-sized instrument, in order to treat the cystitis rationally, is indicated.

In addition to the four exceptions mentioned there are certain strictures **permeable but difficult to be passed.** The smallest sound will not pass, but a filiform whalebone guide can be coaxed through. A succession of increasingly large tunneled sounds (Fig. 599) may be passed on the filiform guide until the passage of an ordinary instrument can be accomplished. Here the choice will be internal urethrotomy if the stenosis is in the penile urethra, provided the caliber can be brought up to the point necessary for the introduction of an Otis or other urethrotome; if this cannot be done, external urethrotomy, either in the penile, bulbous, or membranous portion of the canal, will be indicated.

There is a growing tendency among surgeons at the present time to limit operations on permeable strictures to (1) gradual dilatation; (2) external urethrotomy. This is based on the principles of modern surgery, every step of the cutting operation as practised from without being under exact control. On the other hand, **rapid divulsion** leaves the patient's fate to the effects of complicated instruments which are absolutely beyond control and should be rejected without hesitation. It is only a question of time when internal urethrotomy will also be abandoned on the same ground, in spite of the genius of its chief American advocate, Prof. Otis, and the relative perfection to which he has brought the procedure. There is no doubt that both operations may induce urinary extravasation; this is particularly true of divulsion. External urethrotomy, on the other hand, absolutely prevents this complication. In addition to this, it has been claimed that recurrences are less frequent after external urethrotomy (W. Roser), the broad scar of the soft parts dragging in an outward direction the incised portion of the canal. In addition, a lower mortality has been claimed for external urethrotomy as compared with internal urethrotomy (3 per cent as against 5 per cent, Gregory).

Overdilatation of the urethra (Otis), whatever method is employed, it has been claimed insures more certainly against recurrence than where simply the normal caliber is reached. In gradual dilatation patients will rarely submit to this; in dilatation, with or without internal urethrotomy, overstretching of the urethra is probably always done and divulsion of the stricture frequently occurs. Even here it will not always secure the patient against relapse.

Impermeable strictures should never be submitted to the dangerous attempt of **forced catheterization,** as formerly taught. In case of **retention of urine,** suprapubic puncture or aspiration is to be selected as a palliative measure and external urethrotomy applied as a means of cure. Occasionally it will happen that the swelling behind the stricture caused by the presence of decomposed urine will subside after a period of rest of the parts. This may be accomplished by suprapubic puncture, leaving the cannula *in situ*, or, what is preferable, suprapubic aspiration of the bladder repeated every eight or ten hours; the patient is thereby finally enabled to urinate through the urethra. Under these circumstances the introduction of an instrument through the stricture may become possible, an impermeable stricture being thus converted into a permeable stricture.

Suppurating fistulous tracks, if they have their origin in the urethral canal and are due to the presence of stricture, demand external urethrotomy, whether the stricture is permeable or impermeable. With free division from without and vigorous curettage of the fistulous tracks, a rapid cure may be frequently obtained; on the other hand, months and sometimes years are consumed in attempting to correct this condition of affairs by operations from within and by cauterization of the fistulas.

Urethroscopy.—It is not possible to inspect the urethra directly for any considerable distance. In order to bring the parts beyond what can be seen by separating the lips of the meatus in view, some contrivance is needed both to separate its walls and to illuminate the cavity thus formed. The instrument designed to accomplish these two objects is called a **urethroscope** (see Fig. 606). The instrument known as the "cold lamp" urethroscope is to be preferred.

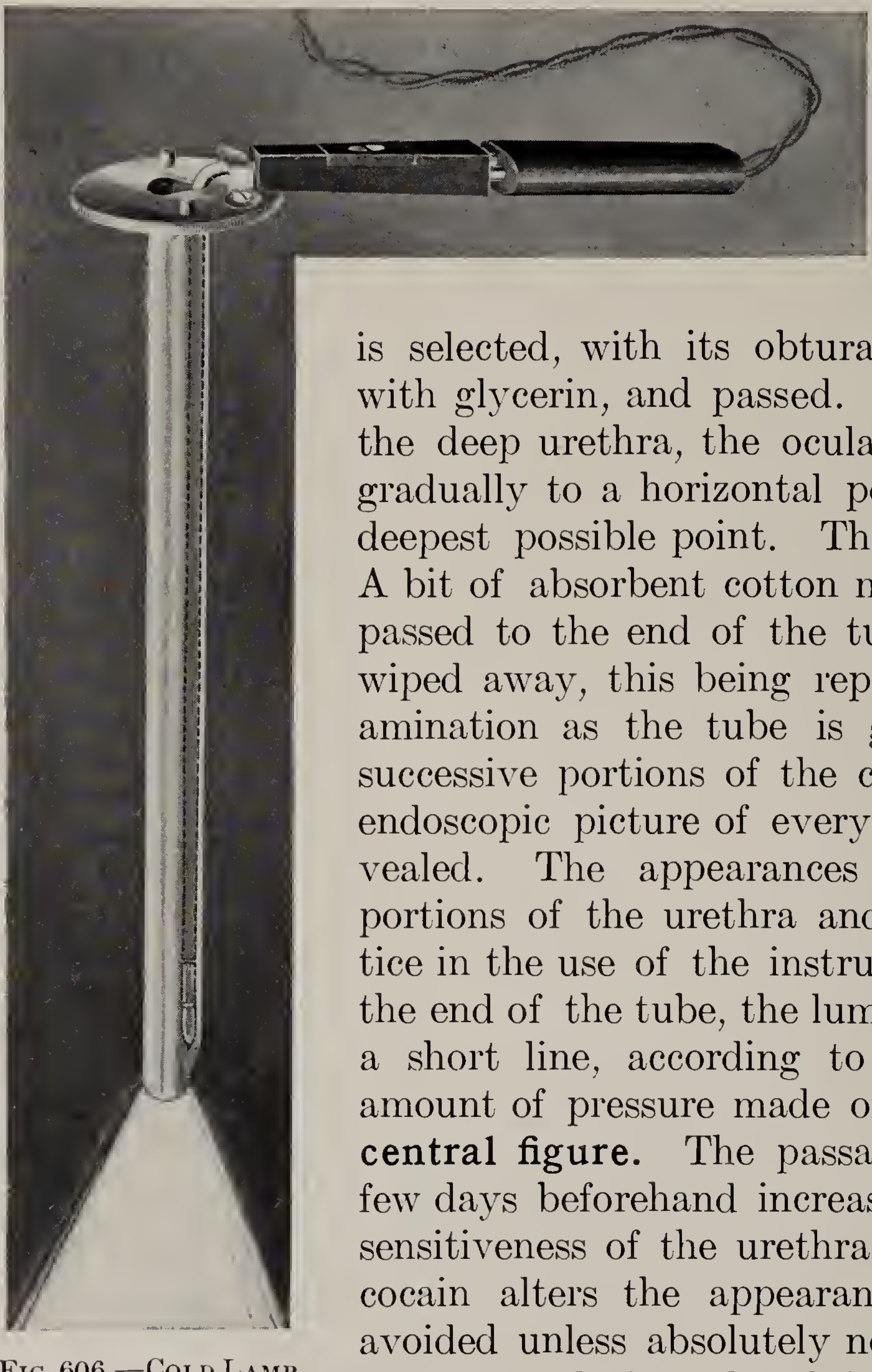

FIG. 606.—COLD LAMP URETHROSCOPE.

Method of Examination.—A proper sized tube is selected, with its obturator *in situ,* sterilized, covered with glycerin, and passed. If it is intended to examine the deep urethra, the ocular end of the tube is brought gradually to a horizontal position, in order to reach the deepest possible point. The obturator is now withdrawn. A bit of absorbent cotton mounted on a slender carrier is passed to the end of the tube and any glycerin or mucus wiped away, this being repeated in the course of the examination as the tube is gradually withdrawn to bring successive portions of the canal into the field of view, an endoscopic picture of every portion of the latter being revealed. The appearances will vary with the different portions of the urethra and can be best studied by practice in the use of the instrument. The canal collapses at the end of the tube, the lumen being reduced to a point or a short line, according to the part examined and the amount of pressure made on the tube. This is called the **central figure.** The passage of a full-sized sound for a few days beforehand increases the caliber and lessens the sensitiveness of the urethra. The preliminary injection of cocain alters the appearances somewhat and should be avoided unless absolutely necessary. A few drops of a 4 per cent solution placed just within the orifice will frequently suffice.

The **pathologic appearances** present will determine the character of the picture presented. Differences will pertain to the color of the mucous membrane, to the character of the surface, and to the volume and elasticity of the urethral walls. **Sclerotic conditions** varying in extent and degree may be present, due to different degrees of infiltration. When the tube is pushed down on a stricture the configuration of the latter may be made out. Spasmodic stricture may thus be differentiated from organic stricture. **Granular patches,** so universally believed to be an accompaniment of chronic urethritis, are not so commonly present in this condition as in affections of the orifices of the glands of Littré. Warts and polypi are sometimes observed, particularly in the extreme anterior portion.

The **intraurethral treatment** of certain of these lesions may be carried out by means of the urethroscope. This may consist of the application of certain drugs in substance, solution, or in powder form; these may be carried to the parts by means of cotton tampons or of a spray. Among these remedies may be mentioned nitrate of silver in from 10 per cent to 50 per cent solution; sulfate of thallin (5 per cent to 12 per cent solution); protargol (0.5 per cent to 10 per cent solution); Lugol's solution (iodin 1, iodid of potassium 2, water 12), combined with a 1 per cent solution of carbolic acid; corrosive sublimate in a 0.5 to a 1 per cent solution in alcohol; tannin, sulfate of copper; solutions of chromic acid (10 to 50 per cent solution); solution of the perchlorid of iron (U. S. P.); iodoform; dermatol; resorcin and trichloracetic acid (10 to 25 per cent solutions). Generally the intraurethral treatment must be carried on for a long time, and in some cases injections and internal remedies may be advantageously substituted for it.

Spasmodic Stricture.—Spasmodic contraction of the compressor urethrae or of the unstriped circular muscular fibers of the urethra at any point may be due to **psychic causes,** or arise from **reflex irritation** having its origin in either an organic stricture or a localized granular urethritis. It may also occur after severe injury or a surgical operation, particularly after operative procedures about the rectum and anus; here, however, inhibition of vesical muscular expulsive force may play an equally important rôle in causing retention. **Relative atresia of the meatus** may, in rare instances, produce spasm of the urethral muscular apparatus. The importance of this etiologic factor, however, has been greatly overrated. If a full-sized sound could be passed without preliminary **meatotomy,** the latter, in the vast majority of cases, would be unnecessary.

Spasmodic stricture, other than that due to the above, occurs most frequently in young men allied in type to hysteric women, *i. e.*, nervous, excitable, and irritable individuals. The symptoms, which, under these circumstances, are sometimes inexplicable, except on the theory of reflex irritation, consist of inability to urinate under certain circumstances (urinary stammering of Paget), erethism, and frequent micturition.

The treatment consists of remedies calculated to reduce reflex susceptibility (the bromids, etc.) and the occasional **passage of a full-sized sound.** Should the meatus be contracted to an extent to render this difficult, it may be enlarged by an incision just sufficiently large for this purpose, but no larger. Under no circumstances should the free incision on the floor of the urethra at the meatus, formerly so much in vogue, be practised.

CONGENITAL DEFORMITIES OF THE URETHRA

Hypospadias is that abnormal condition which results from failure of the two lateral halves of the penis to unite on the lower median surface in the course of fetal development. It may occur in all degrees, from a slight lengthening of the meatus to a complete separation along the entire spongy urethra. It is sometimes associated with certain concomitant deformities, such as **division of the scrotum, torsion** and **atrophy of the penis,** and distortions of the parts from **cicatricial contraction** (so-called **hermaphrodism**). As a result, the urine escapes from an abnormal opening situated on the lower surface of the penis at a variable distance from the extremity of the glans penis. It is the commonest of all urethral malformations. In addition to the developmental theory of its production it has been asserted that rupture of the urethra takes place *in utero* (Kaufmann), it having been shown that the secretion of urine is active during fetal life (Wiener).

Three varieties of hypospadias are recognized, viz., **balanitic, penile,** and **perineal.** These occur in frequency in the order named. In the last named a perfect urethra may exist anterior to the hypospadic opening; the urethra, however, may be closed by a membrane. In some instances a simple **congenital urinary fistula** exists. The opening is always in front of the cut-off muscle, however, and therefore the patient always has control of the escape of urine.

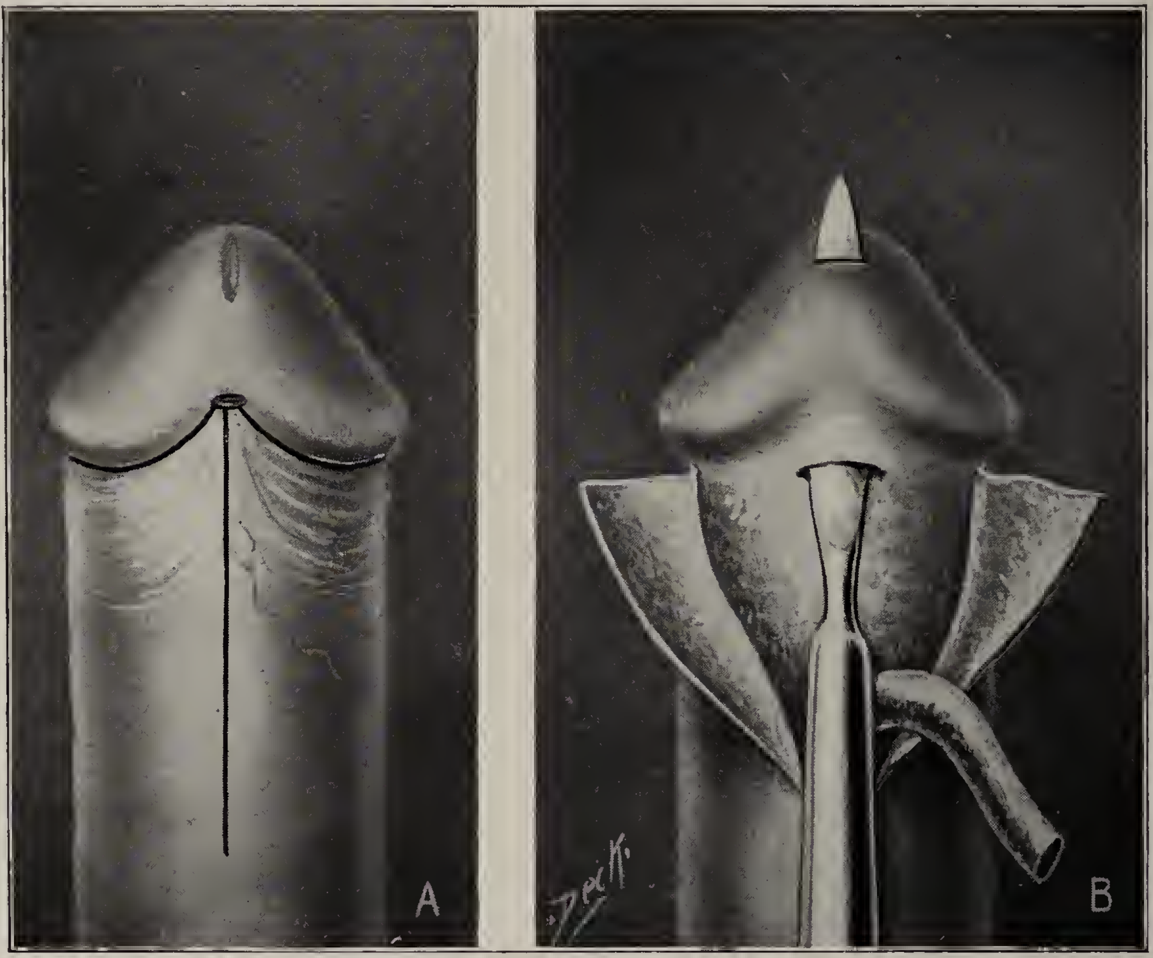

FIG. 607.—BECK'S OPERATION FOR BALANITIC HYPOSPADIAS.
A, Lines of incision; B, tunneling for the urethra.

The **symptoms,** in addition to the changes mentioned, consist of certain derangements of function, such as **disturbances of urination** and of **copulation.** These are most marked in the perineal variety. In the penile variety, though copulation may be normal, fecundation may be abrogated, particularly if the opening lies outside of the vagina during the act. The abnormal downward curve present in hypospadias in the perineal region causes the glans to be forced into the fissure of the scrotum during erection.

The **diagnosis** is usually not difficult. Traumatic splitting of the urethra from the meatus backward in certain insane patients may simulate the condition. **Hermaphrodism** may appear to be present, or difficulty exist in determining the sex in infants if nondescent of the testicle is conjoined with hypospadias. The absence of the uterus and the presence of the prostate will determine the question.

Treatment.—For balanitic hypospadias Beck's operation is the best. The urethra is freed well back after it is exposed by two lateral skin flaps (Fig. 607). A narrow-bladed knife is then entered at the site of the old opening and passed directly forward through the glans. The urethra is then brought through the new opening and sutured to the edges of the latter. Finally, the skin flaps are replaced and sutured (Fig. 608).

In penile hypospadias the penis must first be freed from scrotal adhesions, either by making a transverse incision at the junction of the penis and scrotum, this being sutured transversely, or by dissecting the organ away from the scrotum, together with sufficient skin from the latter to cover in the raw surface on the penis. The incurvation of the body of the penis is to be corrected by a transverse incision made on the under surface through the entire thickness of the sheath of the corpora cavernosa. To this is to be added, if necessary, division of the intercavernous septum to the dorsum. The penis is then forcibly straightened and bandaged on a light splint until healing is completed.

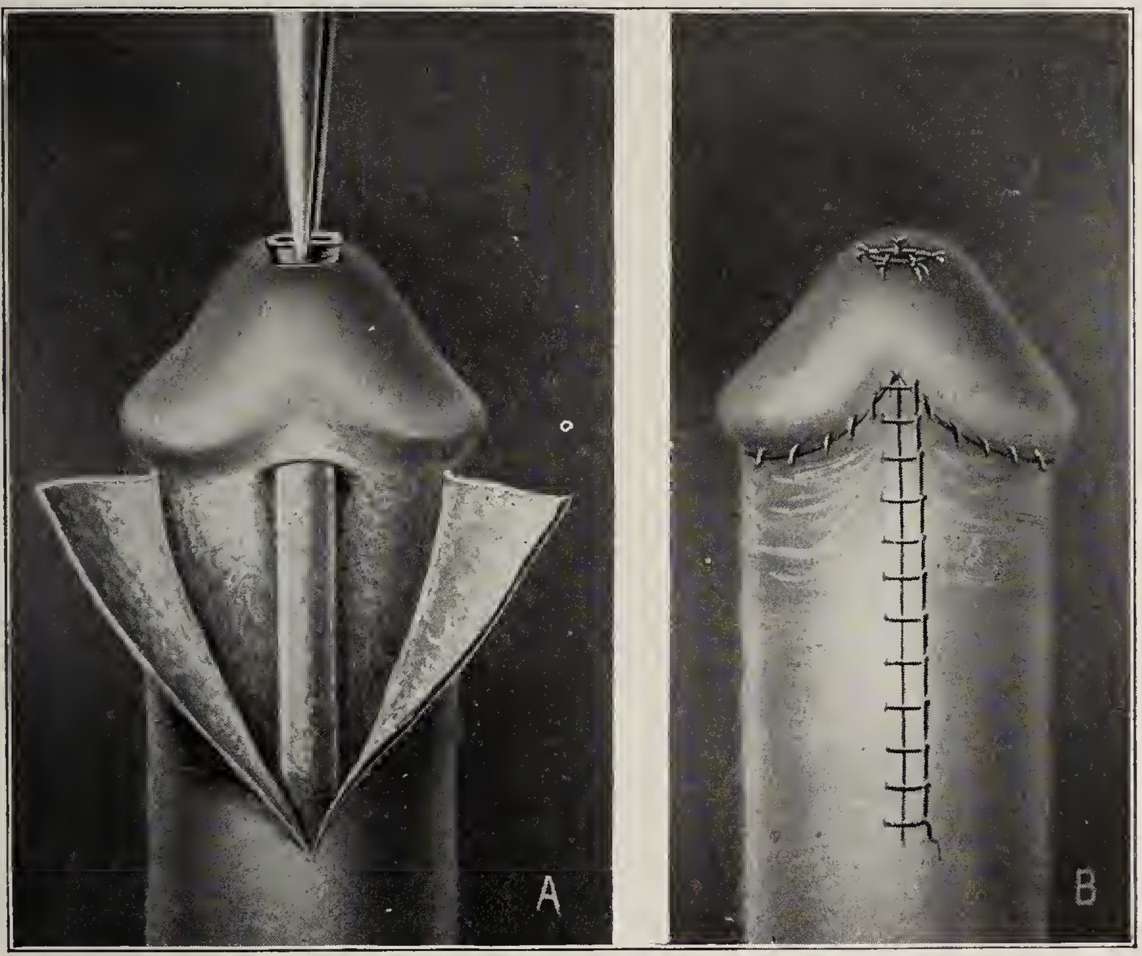

Fig. 608.—Beck's Operation for Balanitic Hypospadias.
A, Urethra in position; B, sutures applied.

When the wounds made in straightening the penis have entirely healed, the urethral canal is to be restored. The operations heretofore devised for this purpose are difficult of performance and still more uncertain in their results. That of Duplay has until recently been preferred by most surgeons. That of Nové-Josserand, as modified by Rochet, is considered the most promising at the present time. A transverse incision about five-eighths of an inch long is made just in front of the hypospadic opening. A free subcutaneous channel is tunneled on the under side of the penis, by means of some blunt instrument, to the base of the glans. A meatus is formed by making a transverse slit in the glans (Fig. 609, A). A flap, with its base at the orifice of the hypospadia, is then taken from the scrotum, and wrapped, with its skin surface turned inward, around a No. 21 French catheter, where it is secured by fine catgut sutures approximating its edges (Fig. 609, B). To prevent slipping in the further manipulation, a catgut ligature is tied tightly about the further extremity and the ends left long. The catheter thus covered is doubled on itself, and, together with the newly formed urethra, aided by the long ends of the catgut ligature, is drawn into place, the ligature cut away, and the edges sutured to the new meatus (Fig. 609, C). The catheter is then pushed into the bladder and used as a retained catheter.

In the original operation of Nové-Josserand an Ollier transplantation graft is taken from the inside of the thigh and sutured with the raw surface about the catheter. The natural and artificial portions of the urethra are joined at a subsequent operation.

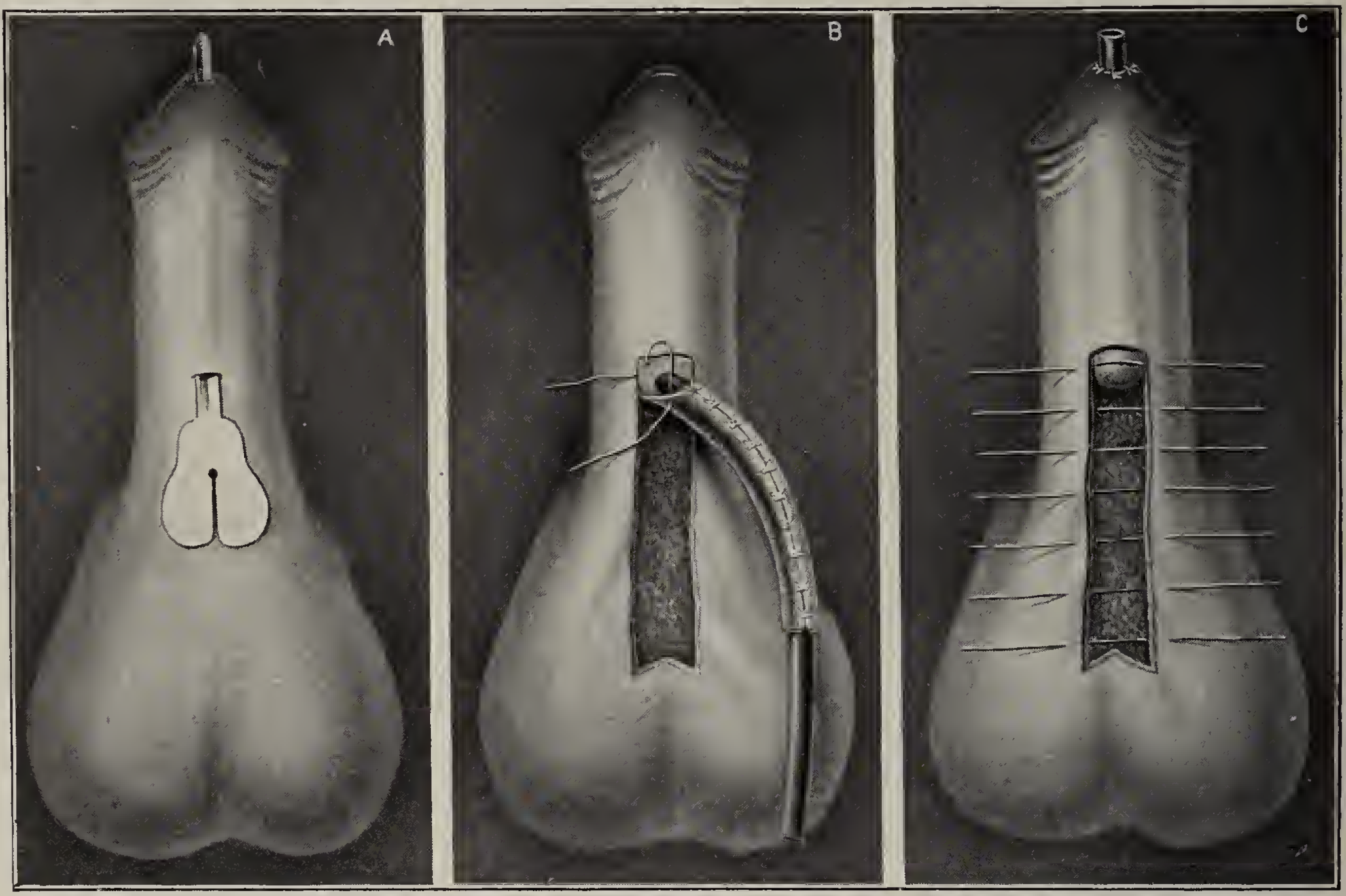

Fig. 609.—Rochet's Operation for Hypospadias.

A, The method of forming the subcutaneous channel; B, flap taken from the scrotum and wrapped, with its skin surface turned inward, around a No. 21 (French) catheter and secured by catgut sutures approximating its edges; C, the catheter doubled on itself and, together with the new urethra, drawn into place.

Epispadias.—In this malformation the division is on the upper wall. It occurs also combined with congenital vesical fissures. The **balanitic** and **penile** varieties only are met with, exclusive of the cases in which the **deep urethra** is involved in conjunction with exstrophy of the bladder. Epispadias of the glans is exceedingly rare; the entire body of the latter may be divided, or, more commonly, the glans is simply furrowed. The prepuce is not involved. In the penile form the urinary opening is usually immediately in front of the site of the symphysis, and the enlarged triangular-shaped prepuce hangs on the scrotum. The glans lies in a depression formed by the absence of the symphysis, with its upper surface in contact with the projecting abdominal wall. The penis is rudimentary, is curved upward, and is almost always twisted. The broad and shallow urethral furrow may extend the entire length of the organ or it may terminate half an inch from the apex of the glans. It is lined with mucous membrane, which gradually merges into the surrounding skin. The groove may be absent or it may be bridged over behind the glans. It terminates in a funnel-shaped opening.

This deformity, like hypospadias, is in all probability due to pressure from within from retention of urine *in utero.* The parts which give way are probably delayed in development and the rupture occurs in the direction of least resistance.

The **symptoms** demanding attention are incontinence, either partial or complete, and imperfect copulation; fecundation is impossible.

Treatment.—The operative treatment of epispadias has heretofore proved exceedingly unsatisfactory. Where the sphincter power is not lost, interference is not called for; operations undertaken for the purpose of establishing continence of urine uniformly fail. The most that can be done is to cover the groove on the dorsum and convert it into a tube, whereby the urine may be more readily conveyed to some form of apparatus designed to prevent soiling of the clothing. For this purpose the plastic operations of Duplay and Thiersch have been given most frequent trial. The results, even from the palliative standpoint, however, have been far from encouraging. It has been suggested to apply the Nové-Josserand operation for hypospadias to cases of simple penile epispadias (Keyes). Maydl's method of ureterotrigonal anastomosis or implantation of the bladder wall surrounding the mouths of the ureters into the sigmoid flexure or rectum, or the operation of ureterorectostomy, may be applied (see Exstrophy of the Bladder).

Diverticula of the urethra constitute a very rare malformation. The pouch is situated on the under side of the penile urethra and when distended is of large size. This deformity is due to a disturbance of the exact apposition of the glandular and penile portions of the urethra, which develop separately from opposite directions. The **diagnosis** is established by passing a sound into the urethra and feeling its point in the sac. The **treatment** is operative and consists in splitting the wall of the pouch on a staff and cutting out a segment from the wall of the sac, sufficient being left to form, when united, a tube continuous with the urethra.

TUMORS OF THE URETHRA

All the reported cases of **carcinoma of the male urethra** have occurred as a sequel of traumatic or gonorrheal stricture, in patients from forty-eight to seventy-two years of age. The symptoms, beyond those due to **urethral stenosis,** are obscure until infiltration, and perhaps **perineal phlegmon,** takes place. The bulb of the urethra, the soft parts of the perineum, and even the bony portions of the pelvis may be attacked.

The **diagnosis,** in the majority of cases observed, was not established until after perineal section had been performed for the relief of obstructive retention. **Urethral hemorrhage** following careful introduction of the soft catheter led Oberlander, of Dresden, to make a urethroscopic examination, when a raspberry-like growth was discovered, microscopic sections from which proved it to be carcinoma. **Palpation** at the perineum may reveal a hard mass the size of a hazelnut (too large for an ordinary stricture). Such a mass may occur in connection with cancer of Cowper's glands, but its development is not preceded by disturbances of urination or difficult catheterization.

Treatment.—Cases of urethral carcinoma are usually inoperable because of the late discovery of the true nature of the disease. Rupprecht operated by the method of **resection of the urethra** (urethrectomy, see page 285), employing a gum elastic catheter as a guide. The urethra was loosened from the corpora cavernosa of the penis and about three inches of it removed. In order to permit approximation of the divided ends without tension, the scrotum was divided in the middle and each half sutured separately so as to retain the testicles in position. The pendulous urethra was then loosened from its attachments, brought down and secured to the stump of the membranous portion by two silk and two catgut sutures. Permanent catheterization was carried out for fourteen days. There was no recurrence after twenty-two months.

Carcinoma of Cowper's Glands.—Three cases have been reported, viz., one each by Kocher, Paquet, and Gussenbauer. The earlier symptoms include local disturbances and pain on sitting and walking and during defecation. As the disease advances disturbances of urination supervene. Early extirpation permits a good prognosis.

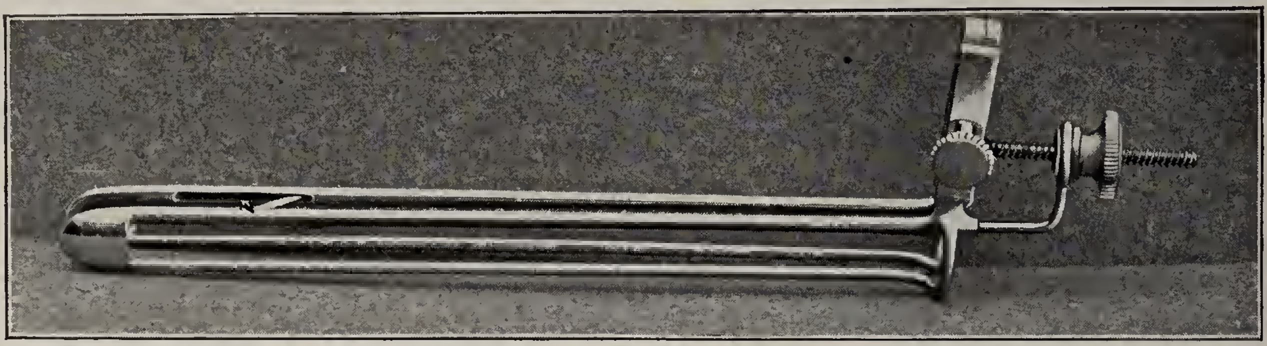

Fig. 610.—Tilden Brown's Wire Urethral Speculum.

Intraurethral vegetations and **polypi** are sometimes observed behind narrowed portions of the canal. Large polypi have been observed in the membranous urethra (Thompson). Beyond a slight discharge and some obstruction to urination, no subjective symptoms are present. Endoscopic examination will reveal the presence of rounded, smooth, or raspberry-like tumors. The **treatment** of the smaller growths is the application of glacial acetic acid; the larger ones are to be removed by means of the long urethral forceps or the polypus scissors. The wire urethral speculum of Dr. F. Tilden Brown (Fig. 610) is useful in exposing the growth for removal.

Tuberculosis of the urethra is of very rare occurrence as a primary affection. Ulcerative destruction of the membranous urethra may occur as the result of infection from the passage of tuberculous urine and the posterior urethra may be invaded from the direction of the prostate. Tuberculous ulcers of the anterior portion may occur. Miliary tuberculosis of the urethra may be observed in the last stages of phthisis. The **symptoms** are excessive pain on urination and a disposition to bleed on the slightest provocation. Urethral discharge, when present, is purulent. The **diagnosis** is made on the basis of the above symptoms and the disproportionate amount of pain in a urethra not actually inflamed (Bryson). Satisfactory cocain anesthesia is very difficult to obtain and this fact renders the use of the urethroscope almost impossible (Fenwick). The first flow of urine from the urethra contains tuberculous detritus. Tubercle bacilli are rarely found.

The **treatment** consists in the use of mild antiseptic local applications and the employment of opium to relieve pain.

THE BLADDER

Contusion of the bladder is of rare occurrence on account of its protected position. **Vesical hematuria,** the urine being blood-red, **vesical irritability,** and **tenesmus** may be present. In severe cases the bladder may be filled with blood-clots or may contain only sufficient of these to interfere with the flow of urine.

The dangers arising from contusion of the bladder relate to (1) excessive hemorrhage; (2) infection of the blood-coagula and the supervention of a septic cystitis. The use of nonsterilized instruments must be avoided, and the bladder irrigated with a boric acid solution and the 15-volume solution of peroxid of hydrogen diluted two-thirds.

Rupture of the Bladder.—This may be intraperitoneal, extraperitoneal, or subperitoneal. In the latter only the mucous and muscular coats give way, the urine then finding its way beneath the peritoneal covering. Or the rupture may be both intraperitoneal and extraperitoneal. The proportion of intraperitoneal to extraperitoneal rupture is three to one. The favorite situation of intraperitoneal rupture is the superior region of the bladder; next in frequency it occurs in the posterior wall. It occurs most often in a transverse direction. Extraperitoneal lesions are usually found in front (Stein) and in the majority of cases are complicated with fracture of the pelvic bones. The rent is usually linear and may assume any direction; its edges are irregular and everted. Extraperitoneal rents are shorter, on the average, than intraperitoneal ones. In the latter the extent of the tear on the serous surface is greater than that in the other coats. The rent is usually single and the proximity of a portion of intestine may lead to adhesions and arrest of further escape from the bladder.

The accident usually occurs, in intraperitoneal injuries, in drunken men with overdistended bladders, external violence being applied. **Straining** to overcome an obstruction in the urethra may cause rupture. The accident has occurred **during parturition** and in the struggles incident to **anesthetization.** Atony, fatty degeneration, sacculation, and ulceration of the bladder walls are also predisposing causes.

Crush injuries, involving fracture of the pelvic bones, may produce either an intraperitoneal or an extraperitoneal rent, or both. Finally, rupture may occur by **contrecoup,** even when the bladder is comparatively empty, the patient falling from a height on the feet or buttocks. The accident is of more frequent occurrence in women (10 to 1) and is not common in childhood.

The **symptoms** are those of shock, which may, however, be slight or absent (Clarke), severe **suprapubic pain,** incessant **desire to micturate,** and **inability to void urine** beyond a few drops, which may be mixed with blood. **Grave constitutional symptoms,** such as pallid countenance, anxious expression, weak pulse, rising temperature, husky voice, and distended abdomen rapidly supervene in intraperitoneal rupture. Coma, convulsions, and death follow.

In extraperitoneal rupture extensive infiltration of urine will have already taken place by the time the patient rallies from the shock. These symptoms may all be latent for a time and then may develop suddenly and unexpectedly.

The **diagnosis** rests on the history of an injury, the subjective symptoms of pain, and an irresistible desire to micturate if the patient is sufficiently sober to manifest these symptoms. **Catheterization,** if it is positively known that the patient has not urinated for several hours prior to the accident, will be of value, failure to obtain urine under these circumstances being of the greatest significance. The inflation test by hydrogen gas is of doubtful utility. The differentiation between intraperitoneal and extraperitoneal rupture is frequently very difficult. In extraperitoneal cases the injection of fluid increases the limits of dullness, and, if the amount injected and withdrawn by the catheter is afterward compared, the presence or absence of a leak may be made out. **Digital exploration** through a perineal incision has been recommended, but is not likely to assist materially in the diagnosis, though the operation is calculated to afford protection against extravasation, in doubtful cases, if it is followed by the introduction of a drainage-tube into the bladder. In females dilatation of the urethra will effect the object. In all cases in which the symptoms point to rupture of the bladder an exploratory laparotomy should be performed.

The **prognosis** is always grave. The intraperitoneal cases promptly perish if operative interference is not instituted at once, and in extraperitoneal cases, under the same circumstances, the patient rarely lives beyond the second week.

The **treatment** consists in the immediate performance of abdominal section in intraperitoneal ruptures and repair by the Lembert or Czerny sutures. This is to be followed by cleansing of the peritoneal cavity. If the rent is situated well posteriorly and difficulty has been experienced in closing it, drainage, either by the suprapubic or the perineal route, is indicated. In extraperitoneal cases immediate bladder drainage is to be secured. In subperitoneal cases the diagnosis will probably not be made without **exploratory abdominal section,** which should be performed in all doubtful cases. In making the exploratory abdominal section the incision should expose the anterior vesical wall and not involve the peritoneum until investigation has excluded extraperitoneal rupture in this locality. If an extraperitoneal rent is found, it may be closed and the surrounding parts drained, provided there is not much laceration. The safest plan, however, is to employ the rent in the bladder for draining the latter, the abdominal wound being treated open, and to perform a perineal section in addition. No extraperitoneal rupture being discoverable, the abdomen should be opened. After the bladder wound is closed, if urine has escaped into the peritoneal cavity, the latter is to be irrigated with the normal salt solution and drained from its most dependent portion (the space between the bladder and the rectum) by means of a glass tube containing a few strands of wicking, led out of the lower angle of the abdominal wound. The patient should be placed in the elevated head and trunk position in the after-treatment (see page 39).

Gunshot injuries represent the type of punctured and lacerated wounds of the bladder. The prognosis, on account of the provision for escape of urine along the track of the missile, is not so grave as in rupture. **Extraperitoneal gunshot wounds** are far less fatal than intraperitoneal ones, though even in the former a rapidly fatal septic cellulitis may result from failure to interfere. In the latter the patient's life is threatened by a rapidly progressive septic peritonitis. Where the peritoneum is not injured, suprapubic or perineal cystotomy is to be performed as supplementary to drainage of the original wound itself.

Urinary infiltration is to be treated by free incisions and drainage (see Extravasation of Urine). In injuries involving the peritoneum **abdominal section** and **suture** of the injured bladder wall, as well as of other injured viscera, should be performed at once. The peritoneal cavity is to be cleansed with a sterilized normal salt solution. This is to be followed by **permanent catheterization,** or either suprapubic or perineal cystotomy and drainage.

Foreign Bodies in the Bladder.—These may find their way into the bladder either as the result of efforts to titillate the sensitive urethra by such articles as pins, needles, hair-pins, etc., or from the accidental breaking of instruments in the hands of the patient or surgeon. As a result of gunshot wounds, etc., bullets or bits of shell or of clothing may remain in the bladder. A solid article swallowed has been known to pass from the intestine to the bladder by ulceration of the intestinal and bladder walls.

Symptoms.—These give rise, in the course of time, to the same symptoms as stone in the bladder. If the injury arises from a broken instrument, the patient is likely to acquaint his surgeon with the nature of the accident at once; otherwise, not. Either ulceration from pressure, or the formation of a stone with the foreign body as a nucleus, will follow its retention within the bladder. If the ulceration involves the peritoneum, rapidly fatal peritonitis will follow. Otherwise, extravasation of urine in other directions will give rise to extensive septic cellulitis, sloughing of connective-tissue planes, etc.

Diagnosis.—(1) By the history or by examination with the stone searcher; (2) by examination with the electric cystoscope.

Treatment.—The best instrument for the removal of a flexible catheter, or a portion thereof, is a small lithotrite with smooth blades. An anesthetic should be given and care exercised in grasping the foreign body with the lithotrite, so as to bring its end toward the urethral opening, if it is elongated in shape. If this fails, a **suprapubic cystotomy** is preferable to the risks of delay. In the female, dilatation of the urethra will ordinarily suffice. If ulceration and perforation have already taken place, the latter may be intraperitoneal or extraperitoneal. If the former, **abdominal section and drainage** are indicated (see Rupture of the Bladder). Extravasation of urine resulting from extraperitoneal perforation must be treated as in rupture of the bladder. In **calculus** resulting from the presence of a foreign body, unless it is positively known that the latter is small or of a friable nature, suprapubic cystotomy rather than litholapaxy should be chosen for its removal.

Inflammation of the Bladder (**Cystitis**).—Inflammatory processes affecting the urinary bladder are invariably due to infection. A lessened local resistance may occur through damage inflicted on the urinary tract, as, for instance, by instrumentation or by retention of urine.

The following **clinical** types are recognized: (1) gonorrheal cystitis (see page 277); (2) tuberculous cystitis (see page 300); (3) the cystitis of stricture;

(4) the cystitis of calculus; (5) the cystitis of tumor; (6) the cystitis of prostatic origin; (7) the cystitis of instrumentation.

Pathologically these types are divided into (1) the superficial cystitis; (2) the interstitial cystitis; (3) the productive cystitis.

Tuberculous Cystitis.—Primary tuberculous cystitis is rare; the greater number of cases are secondary to disease of the kidneys or the prostate, the seminal vesicles or the epididymis. The trigonal mucosa is the part most frequently affected, and with this is usually associated an involvement of the prostate gland. The symptoms closely resemble those of vesical calculus. The most common age is between fifteen and twenty-five. With but few exceptions a primary chronic cystitis is of tuberculous origin.

The **symptoms** come on with increasing frequency of urination, particularly in the daytime, but later on at night as well. There is pain in the penis, vesical tenesmus, and an occasional cutting short of the stream with increased distress. The symptoms rapidly increase in severity.

On making the **differential diagnosis** it should be borne in mind that the above symptoms occur without history of a preceding attack of renal colic; overexercise does not increase markedly the vesical irritability; the pain is situated in the mid-penis and does not pass forward under the glans; the sudden arrest of the stream is due to voluntary contraction of the compressor urethrae, instead of being involuntary from blockage of the internal meatus, as in stone. Rapid increase in severity of the symptoms and the growing evidences of contracting bladder will serve to distinguish the affection from stone in the bladder. Rectal examination will probably detect the involvement of the prostate. Examination of the urinary deposits will sooner or later reveal the presence of the tubercle bacillus and the use of the cystoscope will greatly aid in the diagnosis. The bladder mucous membrane shows infiltrated areas and ecchymoses, and later on multiple annular ulcers.

The Cystitis of Stricture.—This is of relatively rare occurrence. It usually occurs only after obstruction to the flow of urine of long duration. Acute retention, such as results from traumatic obstruction, may produce cystitis, the sudden overdistention producing congestion. In addition, local inflammation is favored by the increased force of the contractions of the detrusor urinae excited by the obstruction. Finally the existence of an ampulla, which occurs to a greater or lesser extent behind every stricture, and particularly behind those at the bulbomembranous junction, favors the growth and development of bacteria as well as their introduction into the bladder during instrumentation.

The Cystitis of Calculus.—In those instances in which the calculus has formed in the bladder this cystitis precedes the occurrence of the stone. When the calculus is of renal origin, particularly if it is smooth, cystitis is of rather exceptional occurrence until constant violence to the bladder wall occasioned by jolting, etc., produces congestion and thus predisposes to inflammation; or some of the symptoms due to the presence of the stone suggest an exploration of the bladder, and infection is caused by the use of instruments. Fragments of stone left behind after litholapaxy will also cause cystitis through injury of the bladder wall, and subsequent infection.

The Cystitis of Tumors.—Here, as in calculus, the symptoms of vesical disturbance other than cystitis attract attention, and the occurrence of inflammation early in the case is usually due to infection as the result of instrumentation. Later on, when hemorrhage occurs, this furnishes a favorable medium for the propagation of microorganisms; infection is still more readily produced under these circumstances and cystitis is more common.

The Cystitis of Prostatic Origin.—Inflammation of the bladder may occur in hypertrophy of the prostate, either with or without distention of the bladder due to retention of urine. The common cause predisposing to infection is congestion due to (1) increased muscular effort in overcoming the obstruction; (2) distention in cases in which retention occurs; (3) changes in the bladder arising from this increased effort; (4) retention of urine, this furnishing a favorable medium for the growth of microorganisms. In addition to this there are to be mentioned the general lessening of resistance due to age and the introduction of microorganisms into the bladder through the medium of instruments used for purposes of diagnosis or for the relief of an acute retention.

In addition to the above stated conditions, with one or another of which the cystitis may be associated, and which hold a causative relation to inflammatory conditions of the bladder, are to be mentioned the following: (1) **the action of cold,** chilling of the surface of the body occurring in those in whom there are conditions present favorable to infection; (2) increased local congestion due to **prolonged sexual excitement;** (3) the irritating urine of **gout and rheumatism;** (4) **retention of urine** due to compressor spasm, or to detrusor paralysis; (5) the presence of **foreign bodies,** and too large or too **irritating irrigations.**

The pathologic distinctions are fully treated of in works on pathologic anatomy. When the lesion is superficial and the mucous membrane is exclusively affected, the urine may remain acid early in the disease, but it soon becomes decomposed after being passed. The affection is usually transient and recovery may take place without any material damage having been inflicted on the bladder walls. When the inflammation includes the tissues of the bladder wall the disease is known as **interstitial cystitis,** the lesion including the connective tissue, the muscular apparatus, and the serous covering (**pericystitis**). **Suppurative processes** may supervene, these being limited to small abscesses, or the whole bladder may become a mass of suppurating tissue. Permanent injury to the bladder will almost necessarily follow under these circumstances. The inflammation almost always begins as a superficial lesion, the connective tissue and the muscular coat becoming involved later, and the serous covering last of all, unless the pericystitis is a result of extension from without instead of from the muscular coat.

The **cystitis of instrumentation** usually results from the use of catheters, irrigation instruments, or sounds. The instrument may inflict injury without carrying infection, the latter having its origin in some other source; or it may carry infection to a bladder which is the seat of a previous injury or of retention of urine. The occurrence of this form of cystitis can be guarded against only by the employment of sterilized instruments and by the exercise of the greatest care in their use.

The Clinical Course of Cystitis.—The symptoms are almost exclusively local. Constitutional disturbances when present are not due to the disease *per se,* but to complications. The clinical history varies greatly, these variations being due (1) to the causes; (2) to the intensity of the inflammatory process. The symptoms on which the greatest reliance is placed and which, when they are all present, are characteristic of the disease, are (1) **frequent micturition**; (2) **pain**; (3) **pus in the urine.** The clinical importance of these depends on their association in the same case; the presence of any one of them is not distinctive, and either of the first two may be absent. The additional symptom, **hematuria,** is of importance when present. Finally, certain changes in the urine, such as albuminuria and ammoniac decomposition, occur.

Unless atony or paralysis of the bladder is present, **increased frequency of micturition** is a constant symptom in cystitis. In prostatic hypertrophy the desire to urinate is more frequent at night than in the daytime. In the cystitis of calculus, particularly, jolting movements of the body increase the desire to pass water. In cystitis the desire is greater when the patient is in the upright position or moves about. The symptom is due to the local congestion and to contact of the urine with the inflamed mucous membrane of the bladder rather than to a diminution of the capacity of the organ. It increases in urgency as the disease progresses.

Under normal conditions the bladder is almost insensitive to contact of unirritating fluids, but when acutely inflamed its **sensibility** is very intense and it becomes intolerant of even a small quantity of injected fluid. The symptom of **pain** is closely associated with that of frequent micturition, and the intensity of the one increases with that of the other. When the pain is due to tension and contact of fluid contained in the bladder, the pain is greatest just before micturition and is relieved thereby. The sensibility of the urethra to contact with urine which has undergone certain alterations, *e. g.*, ammoniac urine, may be greater than that of the bladder itself. Under these circumstances the pain will be greatest during micturition. In calculus and gonorrheal cystitis, as well as in the acute cystitis of prostatic hypertrophy, the pain will be most severe at the end of micturition. In the first two it will be referred to the urethra and continue after micturition. In stone anovesical tenesmus occurs in addition. When considerable pain is complained of from contact of a smooth instrument with the interior of the bladder wall, or from the injection of what, under normal conditions would be an unirritating fluid, these circumstances may be considered as diagnostic.

Finally, in addition to the pain due to tension and that due to contact, whether of the contents of the bladder or of an instrument, there is a sense of weight in the suprapubic and perineal regions.

Pus in the urine is the most constant of all the symptoms of cystitis. While the amount will vary with the stage of the disease and at different stages of micturition, it is never entirely absent, though sometimes it is so scanty and so intimately mixed with the urine as to require the aid of the microscope for its detection. Usually the greatest amount is voided with the urine which flows at the end of the act. The mixture of pus and urine passed will vary in appearance in different cases. In the commencement of a superficial cystitis with acid urine, the latter collected at the beginning of micturition will contain shreds from the urethra and free pus. In the middle of the act the urine will be cloudy from the intimate mixture of pus and urine, with mucus floating above the sediment. At the end of the act the urine gathered will contain a larger proportion of pus. Urine collected in different glasses and at the different stages of the act will demonstrate these differences. In chronic cystitis with ammoniuria, a glairy, mucilaginous substance is present, the result of the action of the ammonia on the pus, which strongly adheres to the bladder wall before urination and to the bottom of the vessel afterward.

Blood in the urine is not a frequent symptom of cystitis. In acute inflammatory conditions it is a symptom of intense congestion, follows micturition, and results from contact of the bladder walls. The appearance of the blood in a calculus cystitis bears the same relation to micturition, and is due to contact of the bladder walls with the stone. In the cystitis of tumor the blood is intimately mixed with the whole quantity of urine. In this as well as in tuberculosis of the bladder, hemorrhage may precede the occurrence of cystitis. In determining the source of the blood the three-glass test above alluded to may be employed.

Albuminuria, when present, is usually due either to the presence of **blood in the urine** or to some **coexisting renal disease,** rather than to the pus corpuscles, which do not yield an appreciable amount of albumin. When no blood is found on microscopic examination and renal disease can be excluded, the albumin is due to escape of the serum of the blood into the bladder from erosion of its walls in cases of long standing in which more or less extensive areas of the upper layers of the epithelium of the bladder wall have been destroyed. The amount present under these circumstances is usually very small. Finally, albumin may be present in considerable quantities and yet its presence be masked by ammoniac decomposition.

Ammoniac decomposition of the urine occurs as the result of the presence and development of bacteria in the urine in cases of cystitis in which there is either partial or complete retention of urine. The process is one of fermentation in which decomposition of urea takes place, carbonate of ammonia is set free, and the urine becomes strongly alkaline. The action of the ammonia on the pus has already been referred to. In addition, the urine has a characteristic fetid ammoniac odor and becomes thicker in consistence than acid urine. The occurrence of ammoniac fermentation in the bladder is pathognomonic of cystitis.

The Treatment of Cystitis.—The treatment includes prophylaxis as well as the use of palliative and curative measures. In all operative procedures even of the simplest character, aseptic precautions should be taken, including the cleansing and disinfection of the external genitals, and only sterilized instruments should be employed. The accessible portions of the urethra should be thoroughly irrigated with the borosalicylic solution of Thiersch. Oil used for lubricating purposes and cocain solutions may be sources of infection, and should be sterilized by boiling. Unnecessarily frequent catheterization as well as all forms of rough instrumentation must be avoided.

In the treatment of **pain** and **frequency of micturition** there is no one drug that serves the purpose so well as opium. It is best administered in rectal suppositories, with or without hyoscyamus or belladonna. The quantity administered must be governed by the urgency of the symptoms; in the absence of any known idiosyncrasy the object should be to relieve pain and give rest to the bladder. This should be combined with rest in the recumbent position with the thighs and knees flexed and a small pillow placed beneath the latter. The patient may lie on his side when urinating. Applications of compresses wrung out of hot water or the hot-water bag applied at the hypogastrium or the perineum are of service in the relief of pain.

The bowels should be kept open by salines and the use of an occasional enema of hot water to keep the lower bowel empty. The **diet** in acute cases is to be limited to milk, if this agrees, mixed with one of the carbonated waters; if not, broths and gruels may be substituted. Efforts to diminish the quantity of urea by proper diet should be made. To increase the proportion of water the patient should drink freely of some slightly alkaline mineral water. In chronic cases a more varied diet may be allowed, but under all circumstances the food taken should be easy of digestion; stimulating articles of diet, as well as rhubarb and asparagus, are to be avoided. Alcoholic stimulants are not to be given unless the feebleness of the patient demands their use. Sexual excitement is also to be avoided.

The cause of the cystitis should be sought for, and if possible removed. Whatever operative procedure is indicated in the furtherance of this object should be carried out without reference to the existence of cystitis.

It is neither necessary nor desirable to render the urine alkaline, though citrate of potassium may be given for its **diuretic** effect. Urine is more frequently sterile when acid than when alkaline. Attempts may be made to render the urine **antiseptic** by the internal administration of salol or salicin in 15-grain doses three times a day. Urotropin, in doses of 8 grains three or four times a day, is useful in establishing and maintaining an aseptic condition of the urine.

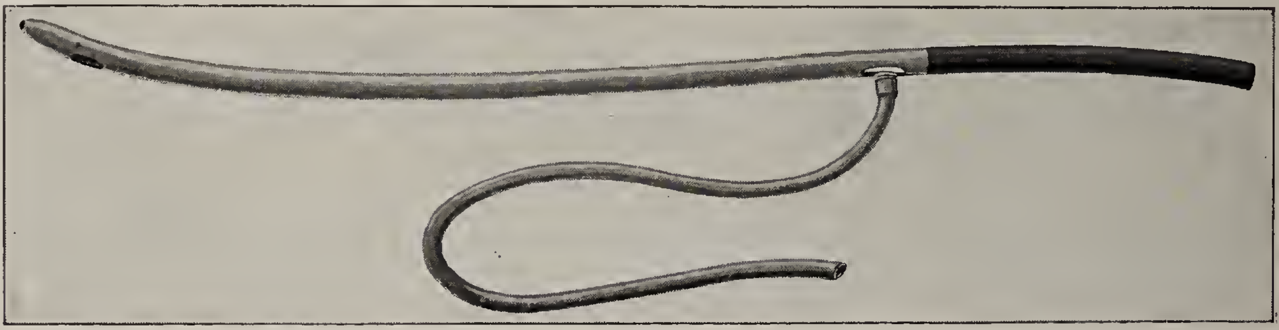

Fig. 611.—Soft-rubber Two-way Catheter for Irrigating the Bladder.

Stagnation of urine should always be prevented, in cases of ammoniac decomposition, by systematic and complete evacuation of the bladder. **Intravesical** irrigations are of value under these circumstances. For this purpose Thiersch's solution, a saturated solution of boric acid, a solution of borax, one dram to the pint, or, in case these produce a burning sensation, a solution of chlorid of sodium, two drams to the pint, may be used. These solutions should always be strained before using. Under no circumstances should the bladder be distended sufficiently to produce pain or an urgent desire to urinate. The soft-rubber two-way catheter is useful for this purpose (Fig. 611). Cleansing once or twice daily is sufficient, and the irrigation should be performed less frequently when the ammoniac fermentation has been arrested. The urethra should be irrigated before each washing.

Injections designed to produce a **local effect** are sometimes used. Strong antiseptic injections should never be made in cystitis. After the intensity of the inflammation, as evinced by the relief of pain and frequency of micturition, has subsided, the best results are obtained by using every other day two ounces of a quarter to a half grain to the ounce solution of nitrate of silver. This may be increased if necessary to a two-grain solution. The solution should be permitted to escape at once.

When the bladder will not hold more than an ounce of fluid without exciting a desire to urinate, **instillations** should be substituted for intravesical injections. A few drops of a weak solution of nitrate of silver are introduced into the prostatic urethra when the bladder is empty, by means of the deep urethral syringe of Keyes, from which point the solution flows backward into the bladder and comes in contact with the neighborhood of the trigonum, where the inflammation is usually the most intense. The strength of the solution for instillation may be gradually increased from a one-half-grain solution to eight grains to the ounce. From 10 to 15 minims, gradually increased, may be used at each daily instillation.

Vesical Drainage.—Permanent catheterization by means of a drainage catheter may be resorted to pending preparations for more radical measures. When the drainage is to be kept up, the **perineal method** is indicated. The urethra is opened in the membranous portion, the prostatic portion and vesical neck dilated with the finger or a Sims's uterine dilator, to prevent subsequent vesical tenesmus, and a full-sized perineal drainage-tube introduced. Injections and instillations may be carried on through this tube. Every effort is to be made to maintain cleanliness of the tube and its surroundings. When the tube is finally removed, the fistulous track, as a rule, quickly closes.

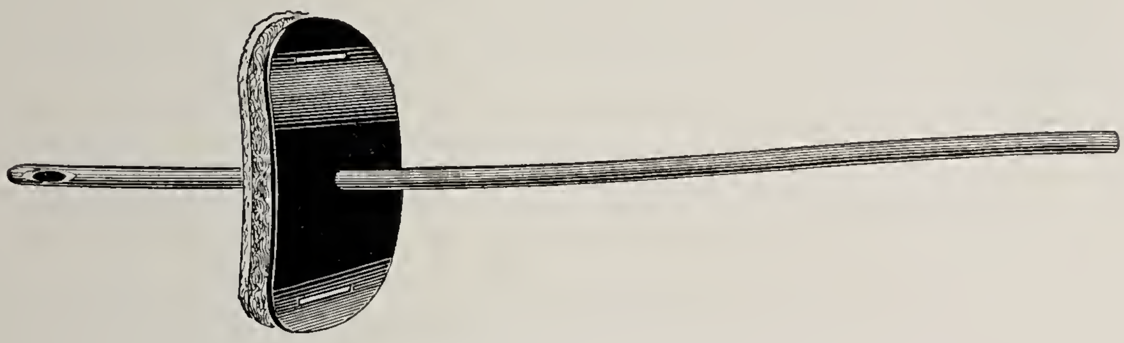

FIG. 612.—DR. L. BOLTON BANGS'S SUPRAPUBIC DRAIN.

Suprapubic drainage may be employed for either temporary or permanent purposes. When it is necessary to prevent the suprapubic opening from closing, the device of Dr. L. Bolton Bangs (Fig. 612) is most useful. For temporary drainage the perineal method is generally employed, but for permanent drainage the suprapubic route is usually to be preferred.

Incontinence of Urine.—In this condition the bladder is unable to retain its contents. In the true sense the term is applied to cases in which the urine escapes as soon as it reaches the bladder, the only restraints to its exit being those offered by the force of gravity and the normal curves of the urinary passages. It is frequently applied, however, to cases of **involuntary and unconscious micturition,** as well as to cases of **uncontrollable micturition,** in which closure of the sphincter vesicae is prevented by asymmetric development of the prostate, or distention is prevented by concentric hypertrophy of the bladder. Diseases of the central nervous system, such as apoplexy, paresis in the later stages, some forms of myelitis, paraplegia, meningitis, locomotor ataxia, and tumors and injuries of the spinal cord, may produce paralysis of the vesical sphincter or the compressor urethrae, and consequent incontinence. Certain malformations of the bladder, as exstrophy, and the results of injuries of the urethra or bladder, such as utero-urethral and vesicovaginal fistulas in the female, and fistulous openings leading to the bladder in either sex, cause incontinence. Relaxation of the sphincter vesicae in grave conditions of disease, as in typhoid and typhus fevers, as well as that occurring in shock, causes incontinence.

Nocturnal incontinence occurs most frequently in children, particularly in male children. It is often due to sleeping with the head and upper portion of the body elevated above the level of the bladder. The slightest relaxation of bladder control in profound slumber permits a drop or two of urine to enter the urethra by force of gravity, at which, in the absence of will-power, as in the waking moments, further control is abolished until the walls of the empty bladder come in contact and contraction of the sphincter vesicae follows. Other causes of incontinence are: physiologic increase in the amount of urine (increased ingestion of water); diabetes and nephritis; excessive acidity or alkalinity of the urine; phimosis, balanitis, and stricture; finally, irritation about the anal margin (pin-worms, eczema, fissure) and the influence of dreams.

Chorea of the bladder, so called, is a variety of involuntary micturition in which the child manages to retain the urine for a short time, the desire, however, becoming so urgent as finally to lead to its expression with a gush, in spite of every effort to control it. The condition is probably due to insufficiency of the sphincter vesicae and the escape of a small quantity of urine into the urethra, where its presence excites an irresistible performance of the act.

True involuntary micturition arises from both hyperesthesia and anesthesia of the mucous membrane of the bladder and urethra. In the former instance the irritability of the bladder excites expulsive efforts which overcome the control exercised by the sphincter; in the latter the bladder walls are stimulated to contract by the tension, while the absence of sensation is such as to render the patient unconscious of the necessity of control.

Disturbances of function of the vesical sphincter are characterized by persistent dribbling of urine.

The **treatment** of incontinence of urine relates mainly to the removal of the cause when possible. In the nocturnal incontinence of childhood, elevation of the pelvis during sleep and the administration of increasingly large doses of tincture of belladonna until the physiologic limit is reached are sometimes beneficial. In adults strychnin in from $\frac{1}{40}$- to $\frac{1}{10}$-grain doses is useful, in addition to the belladonna. In cases due to incompetency of the vesical sphincter in females it has been proposed to separate the urethra from its attachments, including as much as possible of its underlying structures, twisting it from three-quarters to one and a quarter turns on its own axis and suturing it again in position (Gersuny).

Retention of Urine.—This may be defined as a morbid accumulation of urine in the bladder, which continues until it is removed by mechanic means or other therapeutic measures. It may be complete or incomplete and dependent on causes acting on the urethra (obstruction of the channel) or through the bladder (diminished expulsive force). The first named includes those which occur at the urethrovesical orifice, such as the prostatic enlargement of old age; tuberculosis of the prostate; concretions; acute inflammatory swellings; abscesses and tumors; stone and foreign bodies in the bladder; bony displacements from fracture; the presence of the products of cystitis, and blood-clot; stricture and acute congestion added thereto; congenital atresia; rupture of the urethra and false passages; polypi and pediculated tumors of the bladder and urethra, and foreign bodies in the urethra. Diminished expulsive force results from lessened muscular and modified nervous action. Retention due to paralysis of the muscular coats of the bladder follows acute overdistention. Atony follows repeated overdistention and is likewise the result of other causes; retention occurs from this also. Paralysis of the body of the bladder on the one hand, or normal muscular action of the bladder walls and spasmodic action of the vesical neck on the other, may lead to retention. Modified nervous action (inhibition of the lumbar center) and consequent retention frequently follow severe injuries in that region. Operations performed on the urinary organs, the rectum and adjoining parts particularly, and in distant parts as well, also cause retention of urine. General disorders of the nervous system, mental emotion, hysteria, febrile disorders characterized by blunted sensibilities (typhoid and typhus fevers), tumors and diseases of the brain, and paresis are commonly complicated by urinary retention.

Distention with drop-by-drop overflow (**stillicidium urinae**) is relatively much more common than complete retention. This may be mistaken for frequent micturition or even for incontinence. Percussion and palpation over the suprapubic region, examination with the finger in the rectum, and, finally, the introduction of a catheter, will clear up the diagnosis. The most important conditions from which complete retention is to be discriminated are suppression, rupture of the bladder, and extravasation of urine.

Catheterism.—For the purpose of evacuating the bladder, instruments made of metal, silk tissue covered with various gums, and soft rubber are used. The metallic catheter is now seldom employed. It is usually made of silver, is about 12 inches long and in diameter it is from No. 15 to No. 30 of the French scale. One extremity is curved in shape, the curve corresponding to a quarter of a circle from 8 to 10 centimeters in diameter, and has one or more lateral openings or "eyes." Two rings are placed on the handle and serve to identify the position of the beak of the instrument when in the bladder. Flexible catheters may be either curved or straight, usually the latter when made of rubber. Curved flexible catheters are held in shape by a wire stylet. They are also furnished with olive-shaped tips and long tapering extremities. For special purposes, such as entering the bladder over the enlarged middle lobe of the prostate, elbowed and double-elbowed catheters are employed (Fig. 628, B and C). The rubber catheters are of most general service. Their extreme flexibility permits their use by the patients themselves and by nurses.

The probable condition of the urethra should be ascertained if possible before the introduction of a catheter. The position of the patient is also of importance. A proper lubricating material will be required. In difficult cases the previous injection into the urethra of a mixture of one part of cotton-seed oil and two parts of castor oil will be of advantage. Soft catheters are injured by fat, vaselin, and glycerin, and for ordinary use these should be avoided. A useful lubricant is made as follows:

Powdered white Castile soap	oz. j
Water	oz. iij
Mucilage of chondrus crispus	oz. iij
Formalin (40 per cent solution formaldehyde)	♏x
Thymol	gr. v
Oil of thyme	♏v
Alcohol	♏xv

Heat the soap and water and stir until smooth. Add the mucilage (1 ounce of chondrus crispus to 1 pint of water). When cool, pour in the formalin and then the thymol and oil of thyme mixed with the alcohol. Put up in 2-ounce collapsible tubes and sterilize (Gouley).

Bangs's solution of Iceland moss, sold under the name of lubrichondrin, is an excellent lubricant. Except in difficult cases the application of a small amount of the lubricant to the tip of the instrument and to each lip of the meatus suffices.

Technic of Catheterization.—When a metal catheter or sound is passed, the patient should be placed in the recumbent position with his head resting on a pillow, the legs slightly flexed and the thighs separated. The surgeon stands on the patient's left side. The penis, with the foreskin drawn back, is grasped with the left hand. The catheter is held in the right hand, the palm of the latter directed toward the patient's feet. The beak of the instrument is introduced with its shaft held over the fold of the groin and almost touching the skin, until it passes the penile urethra or until all of the curve and an inch or more of the shaft has disappeared. Unless the instrument fits the canal very closely only the gentlest pressure is employed. The penis is drawn over the catheter, the beak following the roof of the canal. As the extremity of the catheter reaches the cul-de-sac of the bulb, as determined by the little finger of the hand that holds the penis, the instrument enters the membranous portion of the urethra, thus completing the **first stage** of the operation (Fig. 613).

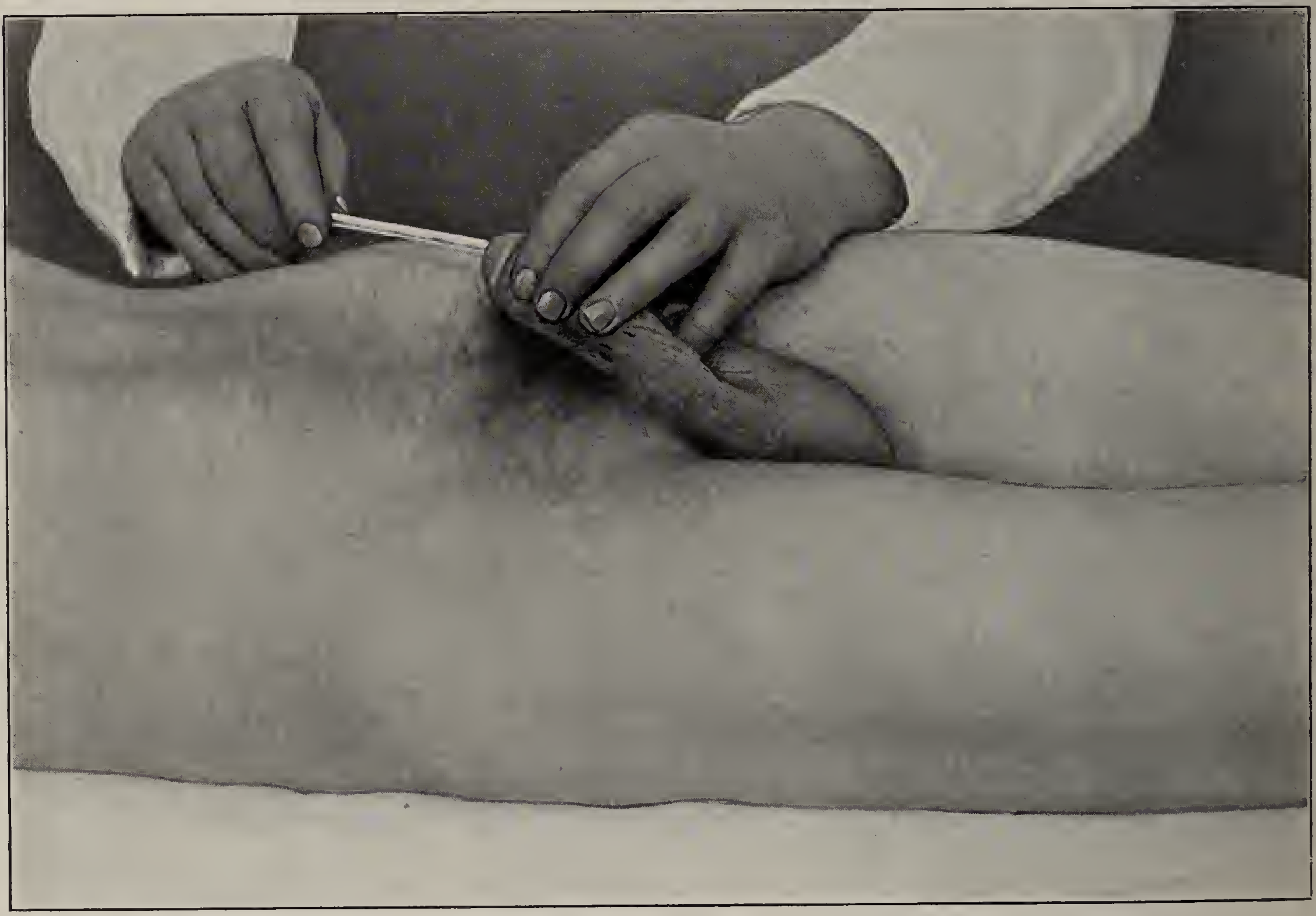

Fig. 613.—The First Stage in the Technic of Catheterization.

In the **second stage** the handle of the instrument is carried to the median line. The shaft is kept well back toward the surface of the abdomen, almost touching the latter. As the beak adapts itself to the subpubic curve the

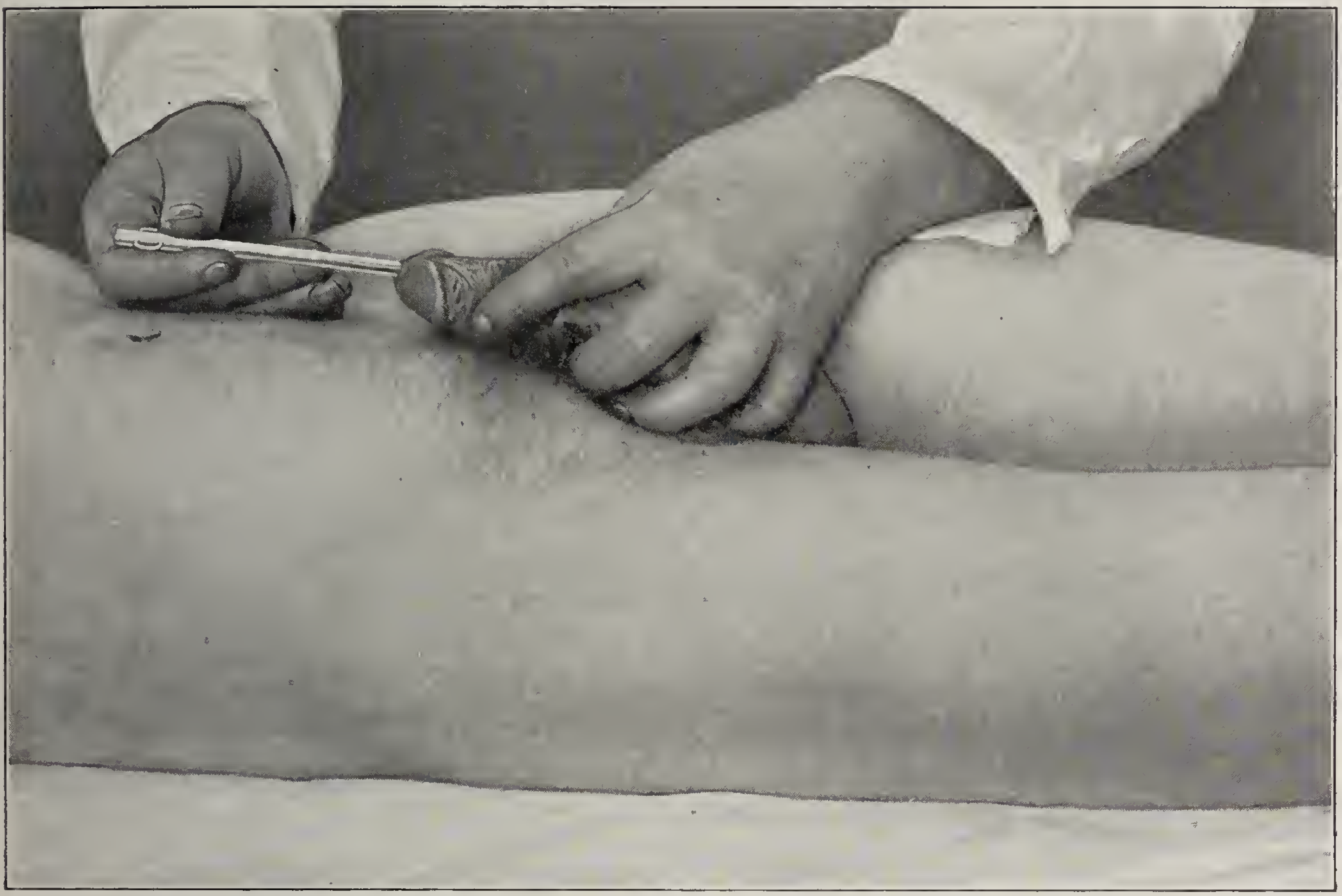

Fig. 614.—The Second Stage in the Technic of Catheterization.

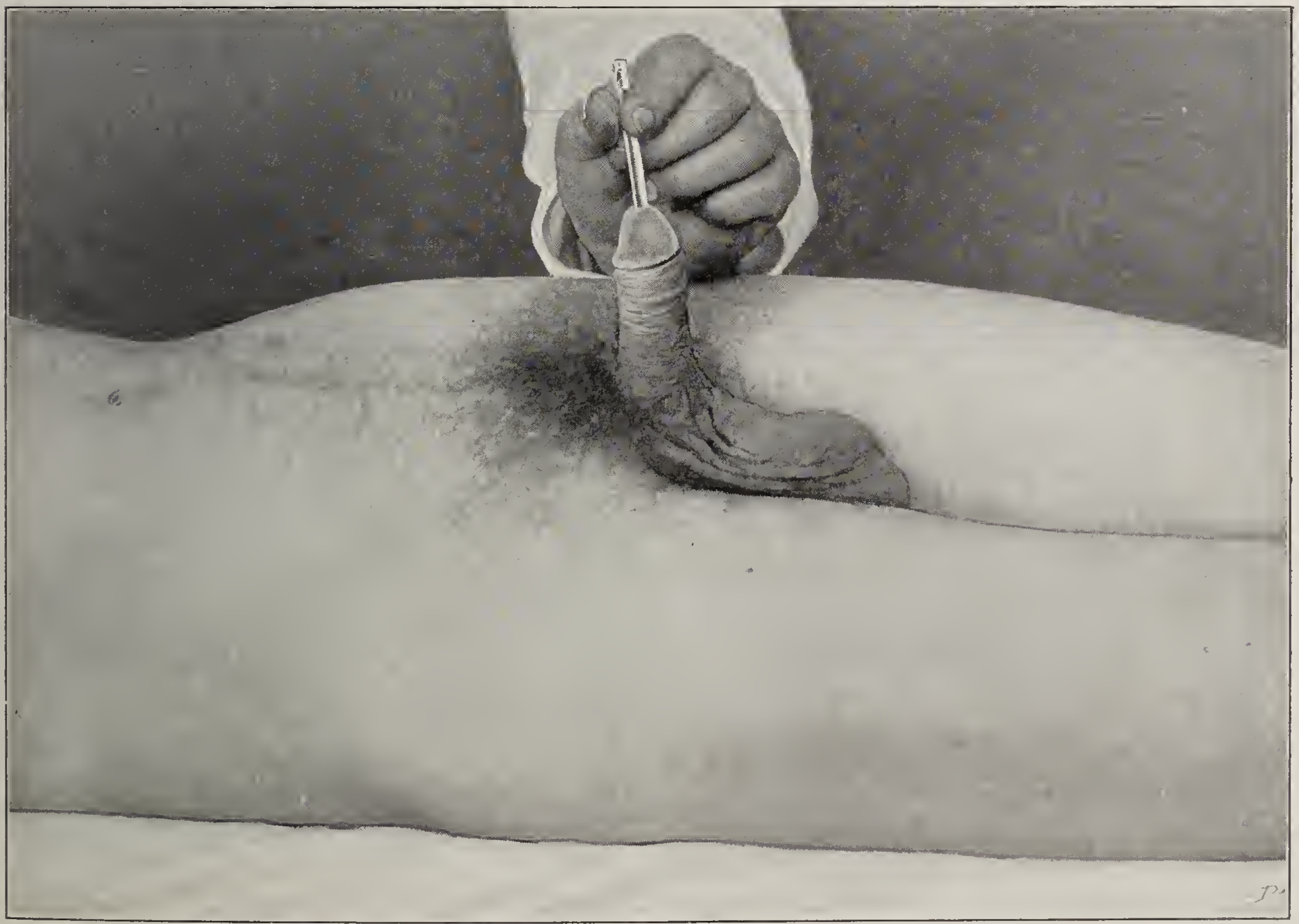

Fig. 615.—The Third Stage in the Technic of Catheterization.
The instrument has been carried in an arc of a circle from the surface of the abdomen, while at the same time it has been advanced still further into the urethra.

penis is released and the scrotum grasped in the hollow of the left hand, while at the same time the parts are pressed against the pubis and upward traction made (Fig. 614). The instrument is now gently advanced until its point lies well against the pubis, when the scrotum, testicles, and penis are released and the instrument transferred to the left hand.

In the **third stage** the instrument is steadied in the median line by the left hand and its shaft carried away from the surface of the abdomen (Fig. 615), the handle describing the arc of a circle during this part of the manipulation. This movement is to be continued until the handle of the instrument almost reaches the meatus. The right hand now makes pressure in a downward direction on the root of the penis to stretch the suspensory ligament and diminish the curve of the membranous portion of the urethra (Fig. 616). At the same time the instrument is depressed between the thighs and slips into the bladder. The entrance of the instrument into the bladder is announced by a flow of urine in the case of a catheter and by the ability to rotate it on its own axis in all directions in the case of a sound.

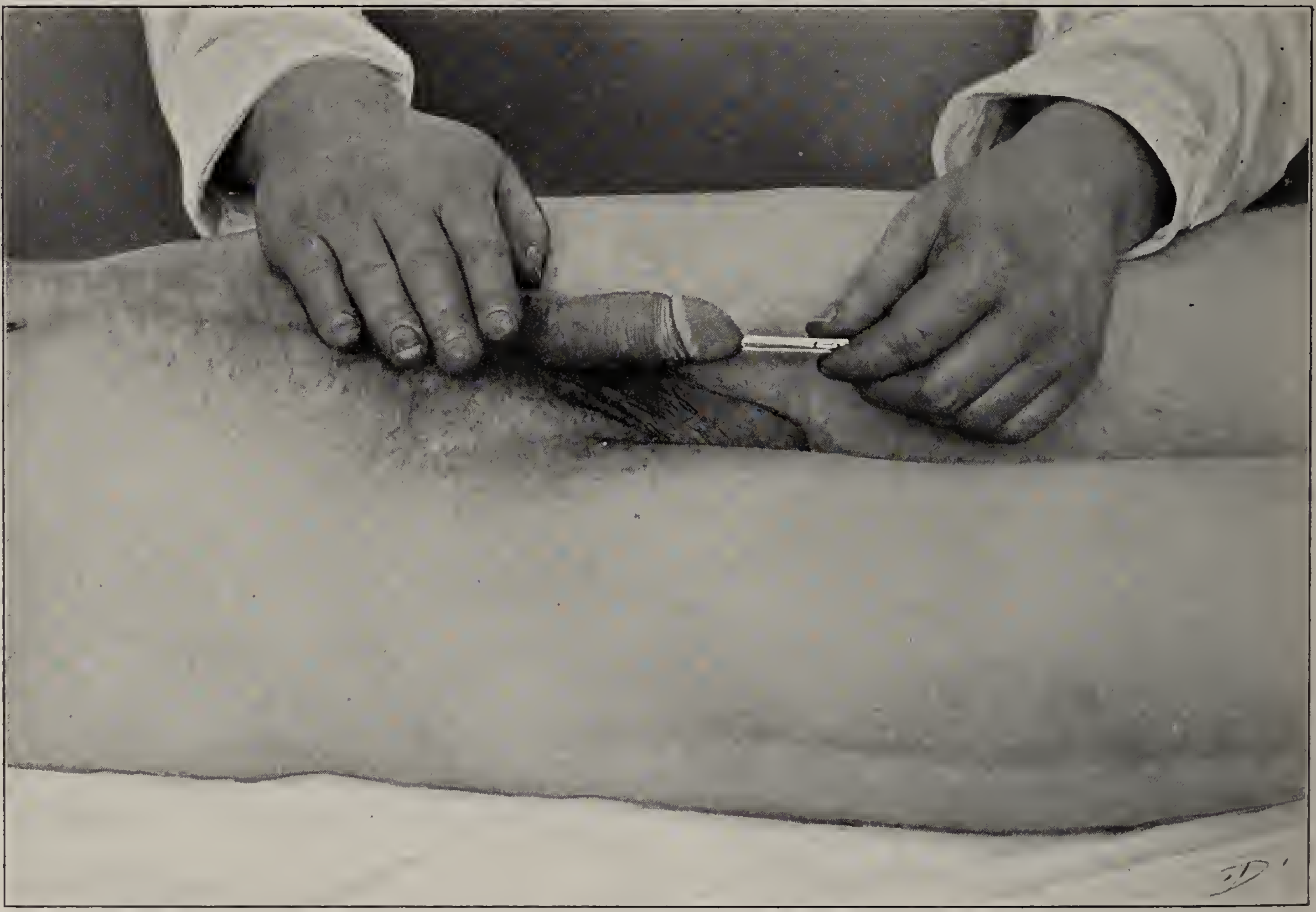

FIG. 616.—THE FOURTH STAGE IN THE TECHNIC OF CATHETERIZATION.
The instrument is depressed between the thighs, and at the same time pressure is made at the root of the penis to stretch the suspensory ligament and diminish the curve of the membranous portion of the urethra.

The passage of the instrument through the curved portion of the canal marks the most difficult stage of the operation. The beak may, at the moment of change in its direction, press the bulb too far down by prematurely lowering the handle, so that the wall is crowded before the instrument. Further progress is blocked and the instrument must be partially withdrawn for another trial.

The method of using a gum-elastic catheter armed with a stylet does not differ from the foregoing. A flexible catheter of vulcanized rubber is easily passed, under normal conditions, by simply "feeding" it in, a half-inch at a time.

Puncture of the Bladder.—This operation may be indicated when catheterization is impossible and retention of urine is present. The urgency of the demand for the operation will depend on whether the retention is complete or incomplete, though the mere fact that the bladder is overdistended and no catheter can be passed is sufficient justification for the operation. It is applied as a temporary measure of relief pending the subsidence of spasm and congestion, or as a permanent means of exit for the urine when the urethra is obliterated. The operation is easily and safely performed by the suprapubic route. The space immediately above the pubic bone devoid of peritoneum is always increased in distention of the viscus. If the puncture is to be made by the trocar and cannula, a small skin incision should be made beforehand. If the aspirating needle is employed this may be omitted. The latter is to be invariably used when the operation is performed as a temporary expedient. If a trocar is used this should be curved (Fig. 617) and introduced with its convexity upward in order the more certainly to avoid the peritoneum. If permanent puncture has been made, the bladder may be washed out through a small soft-rubber catheter introduced through the cannula. If aspiration has been employed, irrigation may be deferred until the viscus can be reached by the natural route. After aspiration a simple strip of adhesive plaster sterilized by heat may be placed over the site of puncture and covered by an aseptic gauze pad. The needle may be introduced two or more times daily, not necessarily always at the same point, until either the removal of the obstruction is accomplished, or permanent suprapubic drainage is decided on. The permanent cannula may be secured in place by tapes, and either covered by antiseptic dressings or connected by means of rubber tubing, with a receptacle containing an antiseptic fluid (Dittel). The after-treatment consists in maintaining an antiseptic regimen and preventing incrustation deposits on the cannula. The use of the permanent cannula may be abandoned when the introduction of an instrument by the normal route is possible and all false passages which may have been made in attempts at catheterization have healed. The granulating track of the cannula usually closes quickly.

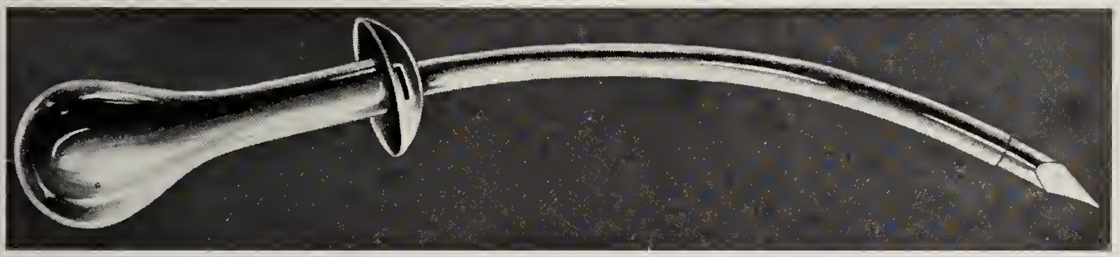

FIG. 617.—CURVED TROCAR AND CANNULA FOR SUPRAPUBIC PUNCTURE OF THE BLADDER.

Fissure of the Neck of the Bladder.—This condition is more common in the female than in the male. In the male the symptoms are similar to those of the spasmodic variety of bar at the vesical neck, viz., frequent and stammering micturition, except that in the latter the "opening and closing" sensation is experienced at the end of the act, as in anal fissure, and is accompanied by the discharge of a few drops of blood following the last of the urine, and a sharp stinging pain referred to the vesical neck. Pressure on the neck of the bladder by the finger in the rectum produces pain at this point and the passage of an instrument into the bladder occasions great distress. The pain is intensified when the urine is acid. In the female the symptoms suggest cystitis, but the pain is more distinctly localized than in the latter disease. Endoscopic examination will assist in the diagnosis. The **treatment** consists in rendering and maintaining the urine alkaline and in applying a nitrate of silver solution, two grains to the ounce, to the prostatic urethra. Intractable cases should be subjected to drainage by perineal incision. In the female the application of the modified nitrate of silver stick, applied through some form of urethral speculum, often succeeds. If this fails, the urethra should be dilated and temporary incontinence produced.

Absence of the Bladder.—Absence of the bladder is of rare occurrence and in the recorded cases only the post mortem has revealed the true condition of affairs. The ureters have been found implanted in either the urethra, the vagina, or the rectum. When the ureters terminate in the urethra, their long extremities have been found dilated.

Double Bladder.—In this exceedingly rare malformation there exists a septum dividing the bladder into two cavities. There may be also a double penis with a separate urethra for each bladder. In a case under the care of Smith, of Baltimore, a stone existed in one of the bladders for which a lithotomy was successfully performed.

Exstrophy of the Bladder.—This is an anomaly of about the second month of fetal life. It occurs from an arrest of development the result of pressure of the umbilic cord on the parts, the fetus, either from greater development of the cephalic extremity or from a more caudal insertion of the cord, combined with an abundance of amniotic fluid, hanging with the head downward. The cord passes between the legs of the fetus and makes pressure exactly at the point where both ectopia vesicae and epispadias develop (Rotgans). The anterior bladder wall fails to develop or develops but imperfectly. In the former case the posterior wall unites at once with the abdominal plates in the line of defect. Retention of urine *in utero* in cases of delayed development may be a factor in the etiology in the latter case. The appearances are characteristic, the posterior bladder wall being thrown into folds and presenting as a dark red, velvety, projecting surface which becomes smaller with the growth of the individual, by a process of cicatrization from the edges. The surface may recede instead of projecting (vesico-abdominal fissure without exstrophy) and the ureters, which in true exstrophy are usually easily identified, cannot be found. This malformation is more common in males than in females (80 to 90 per cent). It is attended by epispadias in the male and by division of the clitoris in the female. The prostate is rudimentary and a double oblique inguinal hernia is usually present. The pubic symphysis may be absent.

Treatment.—The miserable victims of this malformation seldom find relief, though many ingenious operations have been devised for the correction of the defect; but these, as a rule, finally require the use of an artificial receptacle for the urine. The type of operation is that in which a flap from the abdominal wall above the defect is dissected up, turned down with the skin side toward the posterior bladder wall, and covered by sliding lateral flaps. Calcareous material is liable to form on the integumentary surface of the flap which is within the newly formed viscus.

Trendelenburg divides the sacroiliac synchondrosis and brings the sides of the pelvis together in front. The edges of the exstrophy are then pared and approximated by sutures.

Rutkowski operated by isolating and excising a segment of a coil of ileum, leaving the excised portion attached to its mesentery and uniting the ends of the intestine by circular enterorrhaphy. This isolated portion, 6 centimeters in length, was then divided longitudinally, and the quadrilateral flap thus obtained was sutured to the previously detached posterior bladder wall in such a manner as to correct the defect. This gave a urinary bladder with its anterior wall formed by an intestinal flap receiving its nourishment from its own mesentery. The abdominal wall was then closed in over all. A catheter was left *in situ* for permanent drainage. The operation was entirely successful.

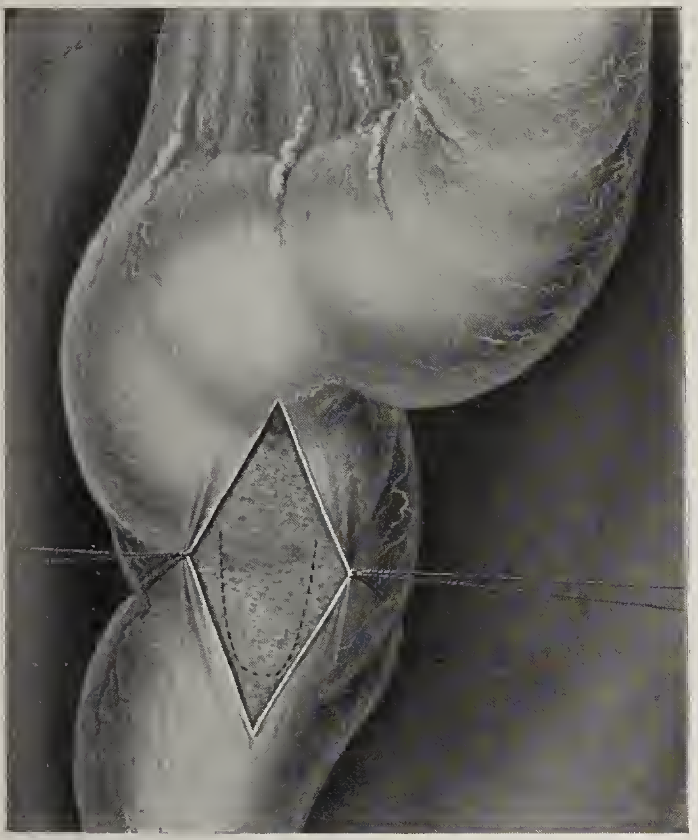

FIG. 618.—URETERORECTAL ANASTOMOSIS.

Incision in the rectal wall, including the serous and muscular coats. Mucous membrane exposed in a diamond-shaped area, and the edges of the incision retracted by thread retractors. The dotted line shows the line of section of the mucous membrane to form the tongue-shaped flap.

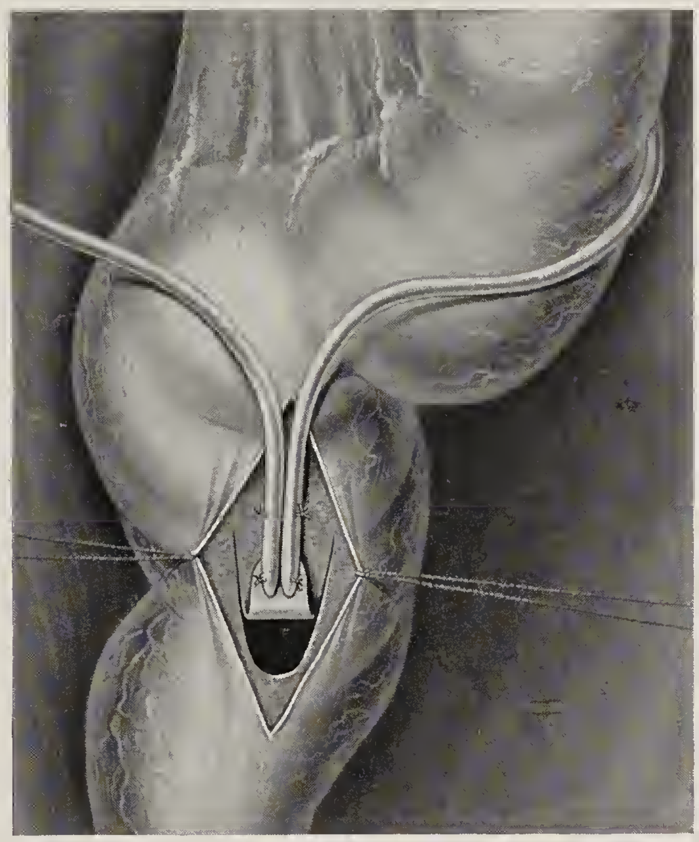

FIG. 619.—URETERORECTAL ANASTOMOSIS.

Tongue-shaped flaps cut and turned back. The ureters are placed with their obliquely cut ends lying on the surface of the flap and secured in place by chromicized catgut sutures.

Ureterorectal anastomosis offers an ideal method of dealing with the inconveniences and discomforts of exstrophy of the bladder, were it not for the dangers of infection of the kidneys. In a case in which I implanted the ureters into the rectum, protecting the opening of the former by means of a flap of mucous membrane, and further providing against infection by placing the ureters in the grasp of the circular fibers of the bowel wall, the patient escaped infection, as far as any symptoms could determine that fact. Over nine years have elapsed since the operation, and the patient, now grown to be a young man, has apparently suffered no inconvenience from the presence of the openings of the ureters in the rectum. The bowel performs its double function as a receptacle for both urine and feces in a very satisfactory manner. The preliminary steps of the operation include (1) a median abdominal section with the patient in the Trendelenburg position; (2) exposure of the ureters by incising the posterior layer of the peritoneum, and their separation from the bladder; (3) oblique section of the ureters at their extremities. The steps of the implantation procedure itself are shown in the accompanying illustrations (Figs. 618, 619, 620, and 621).

Patent Urachus.—The upper half of the intra-abdominal portion of the sac of the allantois which, at or about the seventh month, becomes converted into a fibrous cord extending from the summit of the bladder to the umbilicus, may fail of complete obliteration. In case of complete patency a fistulous communication forms between the navel and the cavity of the bladder (see Cysts of the Urachus). Urine discharges from the navel; calcareous concretions may form along this abnormal urinary tract and inflammatory conditions as well as suppuration may occur. Prolapse of the vesical wall through the patent urachus has been observed. The **treatment** consists in removal of all obstructions in the normal urinary passages. Dilatation of the urethra in the female and perineal cystotomy in the male will procure perfect drainage while means of closing the fistulous opening, such as the injection of alcohol, the application of the actual cautery, or the performance of a plastic operation, are being employed.

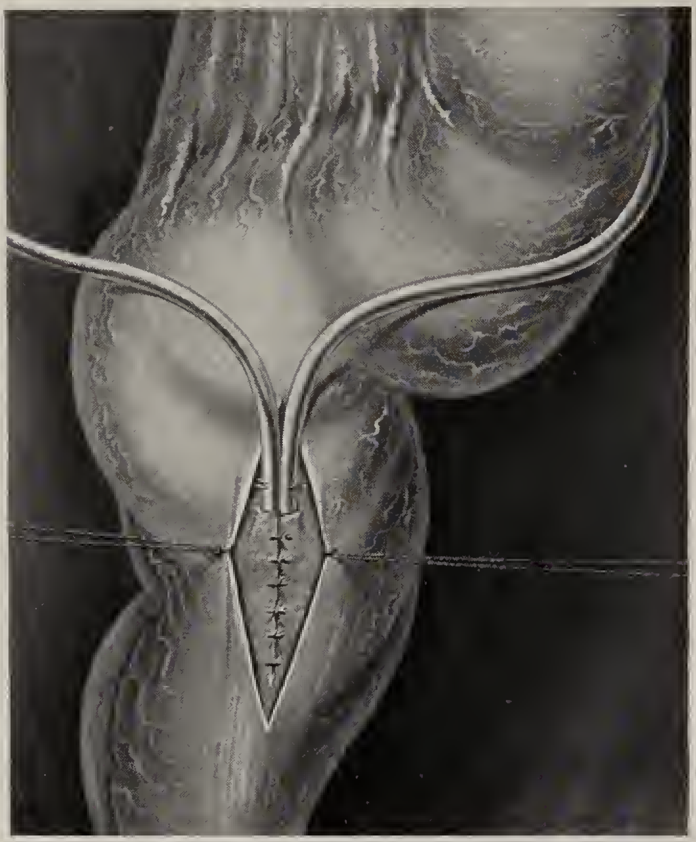

FIG. 620.—URETERORECTAL ANASTOMOSIS.
Flap-valve and ends of ureters placed in the rectum, and a row of chromicized catgut sutures closing the gap in the mucous membrane.

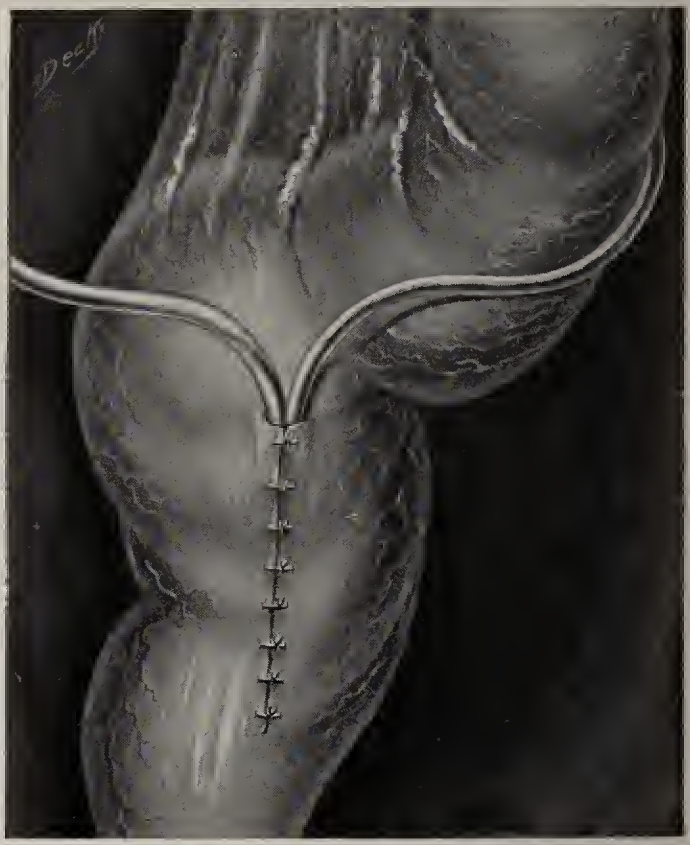

FIG. 621.—URETERORECTAL ANASTOMOSIS.
Showing the longitudinal incision in the bowel-wall closed by a row of silk sutures. The ureters are shown passing into the upper angle of the closed incision.

Hernia of the Bladder.—Cystocele in the male may occur as a complication of intestinal hernia in the inguinal region (see page 185), or the entire protrusion may consist of the bladder alone. It may be direct or indirect, complete or incomplete. Owing to the fact that the bladder is only partially covered by peritoneum, in uncomplicated cases the protrusion is destitute of a sac for the greater part of its extent. When it finds its way into the scrotum, it may be punctured for a hydrocele of the tunica vaginalis. It is also liable to be mistaken for a hydrocele of the cord. It has been mistaken for a diseased testicle and incised (Pott). Attention to the fact that the protrusion varies in size at different times, that it is capable of being emptied by pressure, and that this emptying of the sac is followed by a desire to urinate, will prevent error. It may be necessary to manipulate the protrusion before urination is possible. The **treatment** is that of inguinal hernia.

Inversion of the Bladder.—This is of very rare occurrence. It consists of a literal turning inside out of the bladder, the viscus projecting as a red polypoid mass from the female urethra. It may be complicated with prolapse of the rectum. Rupture of the inverted bladder may occur as a complication (Croft). Its recognition is important; an attempted removal under the belief that it is a polypus would be a fatal error. A history of preceding incontinence and the sudden appearance of a tumor below the clitoris and above the vagina, together with the absence of the urethral orifice, are the principal points to be borne in mind. The **treatment** consists in the reduction of the viscus and the prevention of a relapse. In a persistent case, if searing the parts about the vesical neck with the actual cautery fails, abdominal section and intraperitoneal fixation should be performed.

Hypertrophy of the Bladder.—This is always a symptomatic condition and is to be regarded as the natural result of any condition which persistently stimulates the muscular wall into contraction or demands the exercise of abnormally forcible efforts at expulsion, such as the existence of a stricture. It may be **eccentric** (general dilatation of the bladder) or **concentric,** due to chronic cystitis (contracted bladder). In the eccentric form hernias of the mucous membrane and subcutaneous connective tissue occur through adjoining portions of the muscular fasciculi. The pouches thus formed serve to collect and retain urine, which, undergoing decomposition, may give rise to cystitis. The **treatment** consists in removing the cause and giving the bladder perfect rest by cystotomy. The cystitis should also be treated (see Cystitis, page 303).

Atrophy of the Bladder.—This may occur in aged persons who are thin and emaciated and in cases of paralysis from defective nutrition. Fatty degeneration may take place in a bladder that has been greatly overdistended. Finally, atrophy may occur in a case of extensive vesical fistula, the organ having ceased to perform its functions.

Sacculated Bladder.—This is most commonly observed in connection with the hypertrophy due to prostatic enlargement. Pouches or diverticula form which protrude between separate portions of the muscular coat and in which urine lodges and undergoes decomposition, giving rise to cystitis. These pouches grow deeper and deeper, under the influence of expulsive efforts, until they hold several ounces. They may also become the receptacles of calculous material. The **diagnosis** is difficult. Change in position, after the bladder has been apparently emptied, resulting in a further flow of urine, is diagnostic, as is also the injection of the bladder with a measured quantity and the expulsion of a relatively small quantity when the bladder is permitted to empty itself. Varying appearances in the urine at different stages of the flow when it is drawn through a metal catheter, the beak of the instrument being rotated about in the bladder, are diagnostic (Cadge). **Suppuration** of the sacculus, if posteriorly situated, with discharge into the rectum and the formation of a **rectovesical fistula** and the passage of fecal matter into the bladder, may occur.

When anteriorly or superficially situated, it may rise up in the abdominal cavity and give rise to erroneous operative interference. The **treatment** consists in removal of the cause and the treatment of the complications. Calculous material should be removed by suprapubic cystotomy. Drainage and antiseptic irrigation of the bladder are important. The presence of fecal matter in the bladder is an indication for the performance of suprapubic cystotomy.

Bar at the Neck of the Bladder.—This name has been given to a condition which may occur independently of enlarged prostate or in connection with it. It gives rise to frequent micturition with more or less interference with the free performance of the act. In the **spasmodic** variety, which has sometimes been described as **contracture of the vesical neck** (Delafosse), there is an irregular or spasmodic action of the muscles at the neck of the bladder or "stammering" (Paget), at the commencement of or during micturition. This variety is not necessarily associated with enlarged prostate. The **mucous** variety is associated with enlarged prostate and is characterized by a hyperplastic thickening of the mucous membrane and submucous connective tissue at the apex of the trigonum and between the lateral lobes, in lateral enlargement. It may form a valve-shaped flap at the urethrovesical orifice. **Muscular bar** or **limited hypertrophy** at the trigonum consists of the formation or aggregation of muscular tissue due to a conservative effort on the part of nature to empty the pouch which forms behind the prostate in cases of enlargement of the latter, in which urine tends to collect (Reginald Harrison). The **treatment** of the spasmodic variety consists in the administration of remedies directed to the uric acid diathesis which is usually associated with it, and in the employment of a two-grain to the ounce nitrate of silver solution, applied by means of a deep urethral syringe to the hypersensitive prostatic urethra. In the other two varieties the **treatment** is the treatment of the prostatic enlargement on which they depend (see Enlarged Prostate, page 333).

Tumors of the Bladder and Prostate.—All tumors of the bladder, whether benign or malignant, have a tendency to assume a polypoid or villous character. The reason for this is not apparent. By some it is thought to be due to the alterations in shape which the organ undergoes when it is full and contracting and to the consequent changes in support of the base of the growth. By others it is attributed to some inherent congenital tendency in connection with its development from the allantois.

Papilloma.—True papilloma should not be confounded with tumors of the bladder which simply have a papillomatous or villous surface. Papillomas are generally single and sessile, though they may be multiple and pediculated. The most common form is a typic cauliflower growth, the base or pedicle being distinctly circumscribed and having a number of villous branches projecting from the mucous membrane of the bladder. In the **multiple pediculated** variety the papillae occur separately or in groups and spring directly from the mucous membrane. In **sessile** growths the papillae lie close to the surface. A special form is described which undergoes transformation into a malignant (sarcomatous) growth (Thompson, Harrison).

Mucous and Fibrous Polypi (Myxoma and Myxofibroma).—Myxomas are generally single and resemble nasal polypi. Myxofibromas are essentially true fibromas which have become pediculated and undergo a mucoid transformation, resulting in fibrous polypi.

Myoma.—This growth is made up of muscular fibers and connective tissue. It is generally single and partially pediculated. It may attain the size of a small orange.

Sarcoma.—This belongs to the class of tumors of the bladder to which the name "intermediate transitional" has been given by Sir Henry Thompson for the reason that they present features intermediate between benign papilloma and sarcoma (*vide supra*).

Carcinoma.—Clinically cancer of the bladder may be divided into (1) primary carcinoma; (2) degenerated papilloma. It may also occur, though rarely, as a metastatic, or as a secondary deposit from the intestine, prostate, or uterus. It is more common in women than in men and is very unusual before the age of forty. Primary carcinoma is found as an infiltration of the bladder wall; it probably has its origin in the mucous membrane and is of the squamous-celled variety. It is sessile and projects into the bladder. Ulceration sets in early and a deposit of lime salts forms on the ulcerated surface. Extensive infiltration of the surrounding and underlying tissues occurs. The trigonum is most frequently attacked. It occasionally commences at the orifices of the ureters.

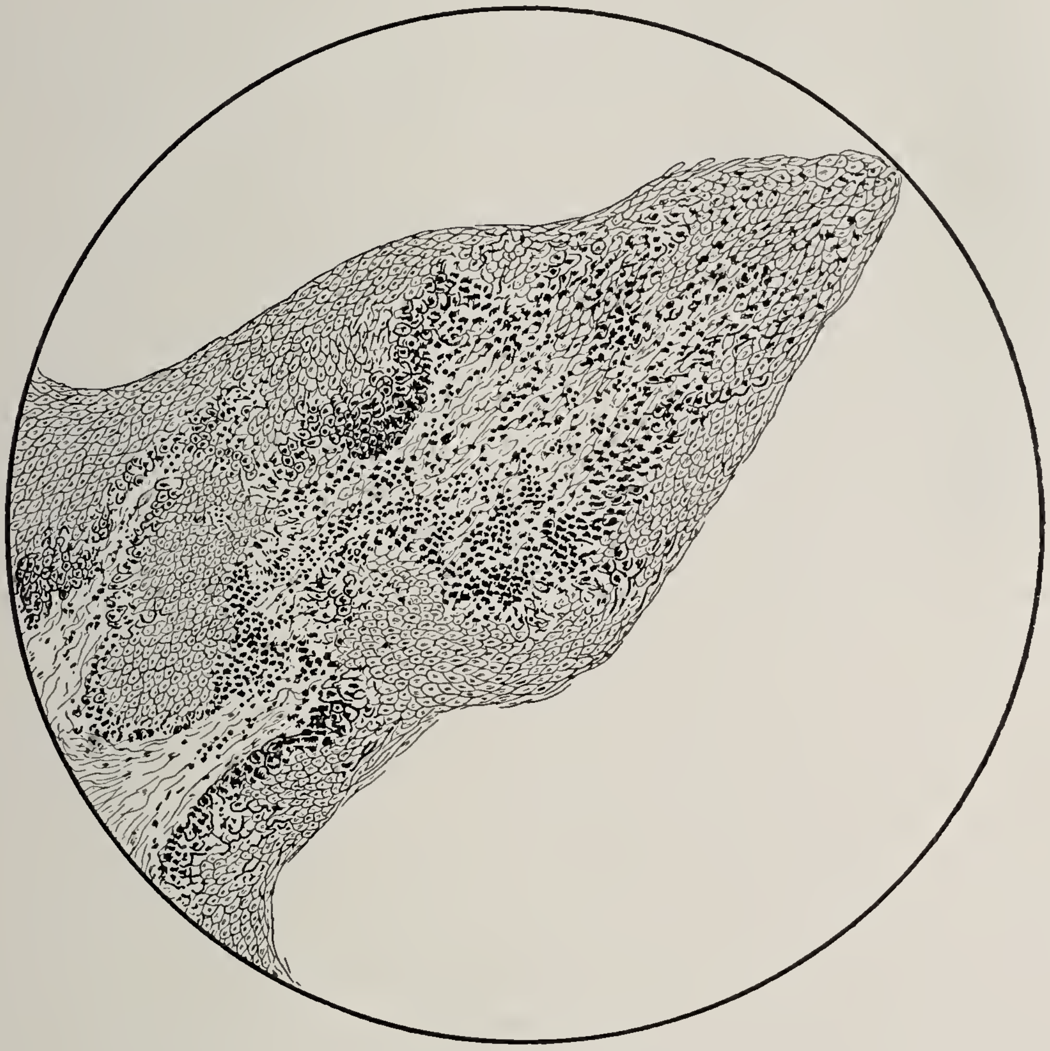

Fig. 622.—Tuft of Papilloma of the Bladder. × 90.

In degenerated papilloma (**papillary carcinoma**) the gross appearances are those of a pure papilloma. The microscope, however, reveals carcinomatous areas, probably the result of degenerative changes in the pedicle. Extension of these occurs as an infiltration at the base, the tumor retaining superficially the appearance of a papilloma. The so-called **relapsing papilloma** belongs to this class.

Symptoms of Tumor of the Bladder.—Myxoma occurs most frequently in children, and in some instances it is believed to be congenital. **Hemorrhage, cystitis,** and **pain** are common to most tumors of the bladder. The bleeding is most noticeable after urination, when the pressure is relieved and the bladder contracts; also after the passage of an instrument, though a severe attack may take place during sleep. It is more abundant than hematuria from other causes (stone in the bladder, renal calculus, ulceration of the surface of a hypertrophied prostate). As the disease advances the hemorrhage becomes more frequent and severe. The bladder may become filled with clots, **retention** and **vesical tenesmus** resulting.

Growths may occur about the ureteral orifices and give rise to hydronephrosis and pyonephrosis.

If the hematuria occurs in a young patient, is only occasionally observed, and the recurrences cover a space of years, a papilloma is most probably present. **Cystitis** may occur later in the case; this depends on the position of the growth and is due to the interference with the function of the bladder, and to the retention of urine. Except in carcinoma the **pain** is due merely to the accompanying cystitis.

Diagnosis.—This is made on the special characteristics of the hemorrhage, the pain and disturbances of micturition, the evidences afforded by the examination of the urine, and the results of cystoscopic examination.

Renal hemorrhage is to be excluded by the absence of renal colic. The smoky urine so frequently observed in cases of bleeding from the kidneys is rarely observed in cancer of the bladder. In malignant disease the pain, as a rule, precedes or accompanies the first appearance of blood, while in papilloma, the development of cystitis being delayed, hemorrhage may be present for a long time before pain is complained of. The pain is not usually aggravated by exercise, as in stone in the bladder. Frequency of micturition is not increased at night, as in prostatic hypertrophy. Digital exploration by the rectum furnishes but little evidence, particularly in the case of benign growths. Negative evidence furnished by the sound should not lead to a final decision. Calcareous material on the surface of both malignant and benign growths may be discovered by this instrument. In the female, however, the urethra may be dilated and the presence of a tumor demonstrated by actual touch. In the latter also opportunity for ocular inspection is sometimes furnished by the protrusion of the tumor from the urethra. Cystoscopy with air distention (Bristow) is of service in making the diagnosis. With water distention the examination is likely to prove unsatisfactory, on account of the bleeding excited and the consequent cloudiness of the fluid in the bladder. Suprapubic section is indicated in the male. Digital examination is justifiable in some obscure cases.

Fragments of villi and bits of tissue from the carcinoma are frequently found in the urine. For the identification of these the urine is placed in a vessel, and when a sediment is deposited the urine is decanted and the sediment repeatedly washed, until free from all traces of blood. It is then examined microscopically for evidences of the suspected growth. Even in cases of indubitable carcinoma the presence of so-called cancer cells is rarely detected in the urine. The presence of renal casts does not exclude the bladder as the cause of the hemorrhage. These may be due to a complicating kidney lesion.

Prognosis.—The progress of bladder growths is usually slow. In benign growths death results from repeated hemorrhages and complicating cystitis and nephritis. In malignant disease exhaustion, hemorrhage, and extension or metastases kill the patient. The average length of life after the first appearance of the symptoms is from three to five years.

Treatment.—Removal of the growth constitutes the only available method of cure. The hemorrhage may be temporarily checked by long-continued irrigation of the bladder (Watson). Vesical tenesmus due to the presence of clots should be held in check by opium, and when the pressure of these has served to arrest the hemorrhage they may be evacuated by irrigation through a large catheter by means of a normal salt solution at 115° F., or a lithotrity evacuator may be employed. In the operative treatment the suprapubic route with Trendelenburg's position is to be preferred.

Distinctly pediculated growths may be burned away close to the bladder wall with the Paquelin cautery or a suitable cautery clamp may be employed (Watson's). Grouped papillomas are best curetted to their common base and the bleeding points of the latter touched with the Paquelin cautery. Infiltrating growths, with the exception of myomas, require resection of the bladder wall, including an area of apparently healthy tissue at least a quarter of an inch beyond the growth. Even in cases in which the disease cannot be radically exterminated much relief may be afforded by thoroughly curetting and permanently draining the bladder.

Cancer of the Bladder.—This is of greater surgical interest from the diagnostic than from the therapeutic standpoint, since operations heretofore instituted for its cure (**partial** or **typic cystectomy,** Tuffier) have proved unsatisfactory.

Cancer of the Ureters.—This occurs at one or the other of the terminal orifices of the ureters and is of surgical interest only in connection with cancer of the bladder or the kidney.

Stone in the Bladder.—Any concretion which the bladder is unable to expel by its natural efforts may be properly denominated a stone in the bladder.

Chemical Characteristics.—Though certain organic substances, such as cystin, xanthin, and indican, may be deposited in the shape of calculi, these are rare. Concretions commonly contain, as their principal ingredients, either uric acid and its salts, oxalate of lime, or phosphates and carbonates, these being sometimes combined with urate of ammonia. A calculus may belong partly in one of these groups and partly in another. Vesical stones also contain albuminous substances which act as a skeleton in which the salts are deposited.

All true calculi contain one or more nuclei and concentric layers of the material of which the calculus is composed. The nucleus may consist of the organic, crystalline, or other constituents of the urine; or it may be a foreign substance.

Etiology.—Calculous disease seems to follow, to some extent, geographic lines, *e. g.*, India and in Egypt; North America is comparatively exempt. **Heredity** is also thought to play a certain rôle in the causation. **Diet** and **habit** have a very decided influence on the occurrence of uric acid and oxalate of lime stones; this is particularly true of the last named. **Diathesis,** or certain tendencies peculiar to the individual, favors its occurrence (*e. g.*, gouty predisposition; hepatic disease). Phosphatic stones are usually the result of local processes. **Alkaline fermentation of the urine** from chronic cystitis, the result of retention from enlarged prostate or stricture in which crystals of triple phosphates as well as other alkaline salts are thrown down, figures in the etiology. These precipitates become deposited in the gelatinized pus, and after undergoing certain changes agglomerate into a mass which becomes the nucleus of the subsequently developed calculus. Or, the retention may, though rarely, be the result of atony of the bladder. In addition, obstructive conditions may lead to stone without the occurrence of alkaline fermentation, crystals or small renal calculi being retained with residual urine and forming the starting-point for a larger concretion.

Symptoms.—A stone, or even a number of stones, may remain in the bladder for a considerable time without causing discomfort. On the other hand, a single small concretion may be the occasion of great suffering which remains unrelieved until the patient undergoes an operation for its removal. In some cases the patients are the subjects of exacerbations of acute suffering, the stone coming in contact with the sensitive vesical neck during these intervals. Usually, however, a few or all of the symptoms are present in a more or less marked degree. The most characteristic, though not, as a rule, the first symptom, is **pain,** aggravated by motion, or during and after micturition. This may vary from a mere sense of discomfort and weight in the perineum to a severe and lancinating pain, referred to the urethra, rectum, or testes, or radiating down the thighs. At the end of urination the pain is referred to the glans penis, the patient dragging on the organ to relieve the discomfort. In children this leads to **lengthening of the prepuce.** Sharp spasms of pain and **vesical** or **rectal tenesmus,** the latter, in children particularly, causing **prolapsus ani,** sometimes occur. **Increased frequency of micturition,** sometimes amounting to a call every few minutes, and aggravated by motion, is a symptom of importance. When the stone rolls over the urethrovesical orifice, there will be a **sudden stoppage of the urine** in the midst of the flow, accompanied by pain. In old persons in whom a postprostatic pouch exists and the stone lies at a greater distance from the vesical neck, this symptom will rarely be observed.

Hematuria from injury to the bladder wall is a somewhat frequent symptom. Cystitis commonly develops as a complication; the urine becomes mixed with pus and bladder epithelial cells, and oxalate of lime or uric acid crystals are found on microscopic examination. These are also found before the development of cystitis, occurring intermittently or in "showers." With the occurrence of alkaline urine crystals of triple phosphates replace, as a rule, the uric acid. **Pus** is most abundant when there is ulceration of the bladder walls, though it is present in considerable quantities when this condition is absent. Alkalinity of the urine causes changes in the condition of the pus, which becomes stringy and clings to the bottom of the vessel. **Albumin** in small quantities may be present with pus or blood, independently of a kidney lesion. Priapism occurs, particularly in the young, from congestion of the vesical neck. **Reflex pains** of a neuralgic character, referred to a distant part (hips, thighs, leg, and specially the great toe and ball of the foot, and the shoulders and arms), occur occasionally.

Diagnosis.—Cystitis, tuberculosis, and tumors of the bladder and prostate are most likely to be mistaken for stone. Physical examination is absolutely necessary to a correct diagnosis. This includes (1) exploration with the sound; (2) exploration with the Bigelow or other form of lithotrity evacuator; (3) the use of the cystoscope.

1. In exploration of the bladder with the sound or Thompson's searcher (Fig. 623) the patient is placed in the horizontal position, with the head low and the hips elevated. The rectum should be empty. Anesthesia should be employed, when practicable, particularly where a previous examination has been negative. A few drops of a 5 per cent solution of cocain in the prostatic urethra and at the vesical neck, may be used at the first examination. If general anesthesia is employed, the surgeon should be prepared to act on the diagnosis thus established and remove the stone. The bladder should be irrigated with a boric acid solution and between three and four ounces of this allowed to remain. Every portion of the organ is to be thoroughly and systematically explored, particular attention being directed in cases of enlarged prostate to the postprostatic pouch, which may be reached by complete rotation of the instrument, the catching of its point being avoided by depressing its handle between the thighs, when necessary. The searcher should be at first carried directly to the fundus, where the stone is usually found. In examining the lateral walls the handle of the sound should be carried to the opposite side and the bladder wall repeatedly tapped by the tip of the instrument as it is withdrawn. With a stone lodged in the postprostatic pouch the finger in the rectum may lift it within reach of the searcher. By the use of the lithotrite an accurate measurement of the stone may be made. Sweeping the point of the sound over the surface of the calculus, however, will give a fair estimate of its size.

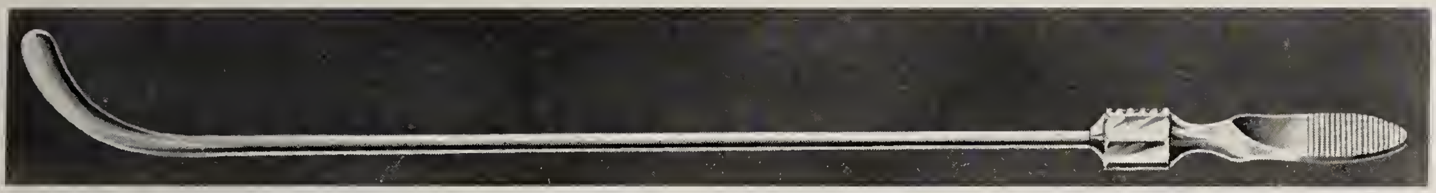

Fig. 623.—Thompson's Stone Searcher.

2. The introduction of the lithotrite evacuating tube having the vacuum bulb attached as a searcher, with suction to bring the stone against the end of the tube, has been employed (Bigelow).

3. The employment of the cystoscope in the hands of one skilled in its use may be of value. Direct digital exploration made through the dilated urethra in women, and by means of a perineal incision, or a suprapubic cystotomy in men, is justifiable in doubtful cases.

Treatment.—The immediate treatment of stone in the bladder resolves itself into (1) solvent measures; (2) operative measures. The first may be dismissed in a few words. Attempts to dissolve the stone, either by the administration of solvent agents by the stomach, or by injections into the bladder, have given but indifferent results. Lithia salts (Garrod) and piperazin (Vogt) have undoubted solvent properties in the case of uric acid. The last named is given in doses of 15 grains daily and is injected into the bladder in a 1 or 2 per cent solution. Urotropin and uricedin are also useful for their antiseptic effect. With the existence of cystitis and ammoniac urine, the calculus is soon encrusted with a layer of the mixed phosphates and further solvent action is prevented.

Relapse may occur after cure from (1) a persistence of the diathesis; (2) successive escape of stones from the kidney; (3) persistence of the local conditions on which the calculus depended, as, for instance, obstructive disease, chronic cystitis, and alkaline fermentation of the urine; (4) retention of a fragment.

Preparation of the Patient for Operation for Stone in the Bladder.—Whatever operative procedure is decided on, certain precautionary measures are highly conducive to a successful result.

The General Health.—The patient, if feeble, should be put to bed and efforts made to increase his body resistance by diet, which should consist largely of milk; easily digested food should be selected for the dietary, and alcoholic stimulants used only moderately, if at all. The bowels should receive attention. Of purely medicinal measures, the administration of strychnin and digitalis, and perhaps quinin and iron, in addition, is the most important.

Examinations of the Urine.—These should be made, with the view of determining the capacity of the kidneys for carrying on their function of the elimination of urea and other excretory products, and for the presence of sugar, albumin, casts, and ammoniac or putrid conditions. If the daily amount of urea eliminated is small, and tube casts or albumin are present indicative of degenerative disease, water (Poland, Geneva, or Clysmic water) and milk in large quantities should be administered. Medicinal agents calculated to raise the blood-pressure and clear the tubular structure of the kidneys of the debris of degenerated epithelium (digitalis, caffein) are indicated.

Antiseptic Preliminary Treatment of the Bladder.—This is of prime importance and should never be neglected in cases of putrid or even cloudy, alkaline urine. Antiseptic irrigation of the bladder following the twice-daily removal of residual urine, should be practised. Solutions of borax or boric acid (one dram to the pint), and of permanganate of potash (1 : 1000), may be used as irrigating fluids, and occasionally a weak solution of nitrate of silver (one-half grain to the ounce) will be beneficial. Very weak solutions of nitric acid are useful in strongly ammoniac urine containing the triple phosphates. The irrigation should be carried on through a double-current catheter and great care should be exercised to avoid distention and consequent spasm. If this latter occurs in spite of every care the irrigations must be suspended and rectal suppositories of opium and belladonna used.

The local measures are to be supplemented by the internal administration of drugs calculated to impart an antiseptic quality to the urine itself, such as urotropin, boric acid, salol, the salicylates, benzoates, and sandalwood oil.

If these preliminary measures are inapplicable in the individual case, or inefficient on account of the great suffering of the patient and an extremely septic condition of the urine, the operation must be undertaken at once.

Operations for Removal of Vesical Calculi.—The operations employed at the present day for the removal of vesical calculi are (1) suprapubic lithotomy; (2) lithotrity. The operation of median lithotomy formerly employed for the removal of small stones has given place to lithotrity. Lateral lithotomy has likewise been practically abandoned. A stone requiring removal by a cutting operation is best dealt with by the suprapubic route.

Choice of Operation.—The size and density of the stone, the condition of the bladder, and the patient's age and condition must all be taken into account. In general terms a small stone and a healthy bladder indicate lithotrity; while the reverse condition, *i. e.*, a large stone and a diseased bladder, indicates lithotomy. The reasons for this are as follows: the smaller the stone, the less bulky the instrument required and the fewer fragments result from the crushing operation; hence the less risk of excessive traumatism and of leaving one or more fragments behind. On the other hand, the presence of a diseased bladder points to the necessity for drainage and other treatment, which can be best accomplished through the operation wound. A small stone in an old man's bladder, in which a retroperitoneal pouch has formed, indicates lithotomy, even if the bladder is otherwise healthy. Few calculi remain in the bladder sufficiently long to attain in their longest diameter a size of two inches without giving rise to marked cystitis, even in the case of comparatively smooth stones, and a stone much smaller than this but having a rough exterior may give rise to a violent cystitis in a comparatively short time. In addition to the foregoing, the possibility that a calculus may conceal a second stone, and the difficulty of reaching the latter because of this, or the fact of its being lodged in a retroperitoneal pouch, must be taken into account.

The Operation of Suprapubic Lithotomy.—The bladder is first to be irrigated thoroughly with the borosalicylic solution of Thiersch and about 10 ounces of the solution allowed to remain in it; less if the bladder is contracted. This is prevented from escaping by a tape tied about the penis. Or, the method of air distention of Dr. Bristow may be employed. The air can be best forced in by means of a clean piece of rubber tubing connected with the catheter introduced into the bladder, the surgeon inflating the latter with his own lungs.

A vertical incision, 2½ inches long, with its lowest limit slightly below the level of the upper surface of the pubes, is made. The prevesical space of Retzius is reached through this incision. The fat occupying the space is separated by blunt dissection and the bladder wall exposed. The latter is steadied by two traction sutures, one on each side of the median line; these are given in charge of an assistant. The bladder is opened by a stab movement with a narrow bistoury, in order to assure division of the mucous membrane. A blunt bistoury is passed and the opening in the bladder enlarged sufficiently to admit the index-finger. The stone is located, seized with stone forceps, and removed. The original opening in the bladder is enlarged if necessary.

If ulcerative conditions are present, the bladder must be drained by a drainage-tube through the suprapubic wound. Dawbarn's apparatus serves an excellent purpose in keeping the parts dry (Fig. 624). Urotropin should be given in 8-grain doses three times a day to disinfect the urine. If the bladder walls are not markedly diseased, the wound in the latter may be closed at once with chromicized catgut, care being taken not to include the mucous membrane. Under no circumstances should the external wound be closed at once; if the bladder wall unites by primary union, the opening in the abdominal wall may be closed by secondary suture, or it may be allowed to heal by granulation.

Owing to improvements in the technic of the operation, as well as in asepsis and antisepsis, suprapubic lithotomy is much more frequently performed in this country at the present time than lithotrity. Though the immediate and direct mortality of the latter is small, recurrences are frequent (20 per cent, Cadge).

Lithotrity.—The patient is placed on his back with the limbs separated and a sand pillow beneath the hips. The bladder is irrigated preliminarily and about 6 ounces of fluid left in the viscus. The lithotrite is introduced, the operation being commenced with the instrument in the horizontal position. It is gradually brought to the upright position as it slips by its own weight along the canal until it reaches the prostatic urethra, when the handle is somewhat depressed; the beak now glides into the cavity of the bladder (Fig. 625). In the case of an enlarged prostate the handle may require to be considerably depressed; the finger passed into the rectum may likewise assist, under these circumstances. Once in the bladder the instrument is held gently in the hand and allowed to glide easily down the trigonum until it encounters the stone. It is now turned away from the calculus, opened, and then rotated toward the stone with the expectation that the latter will fall between its jaws. Should it fail to do so, several maneuvers are recommended. With the jaws of the lithotrite open the stone is sought by turning the instrument first to one side and then to the other, the direction of the beak being changed by tilting it at different angles.

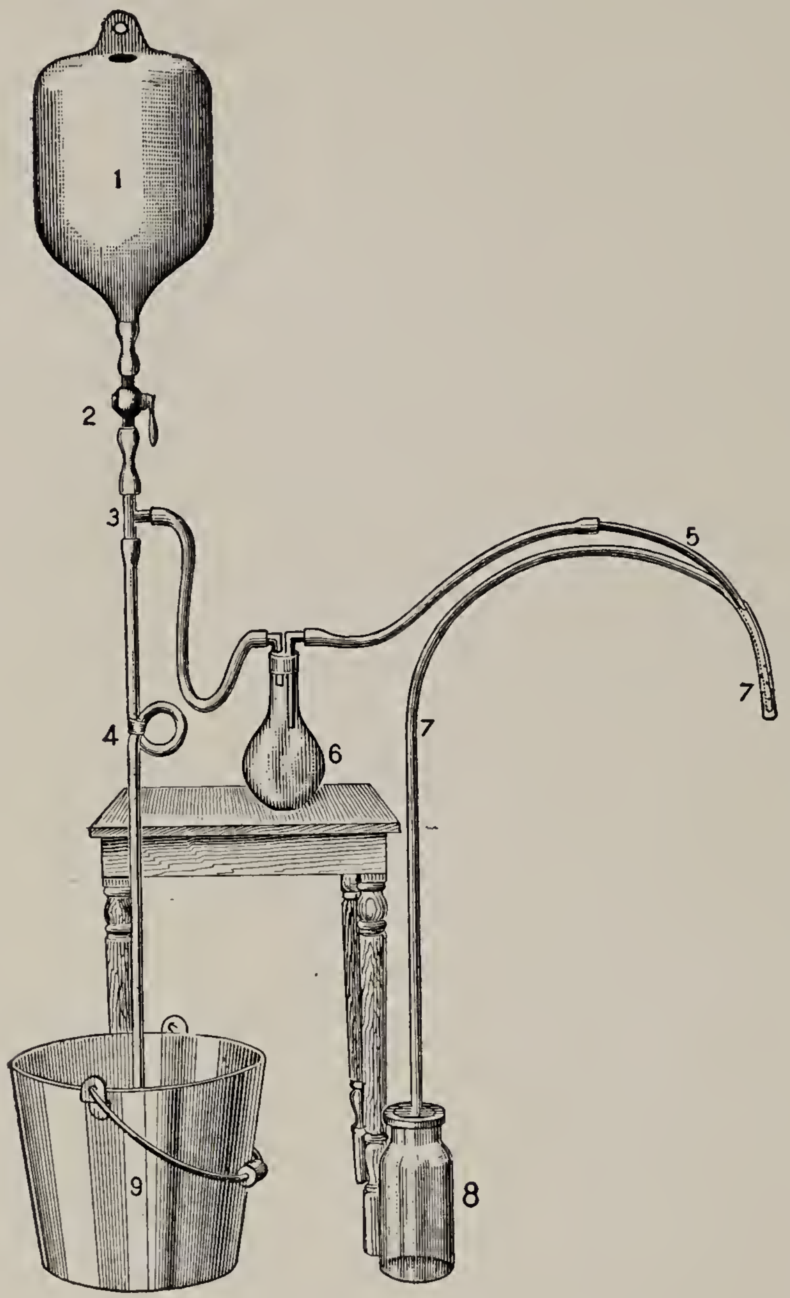

Fig. 624.—Dawbarn's Apparatus for Suprapubic Drainage of the Bladder (Modified).

1, Fountain syringe; 2, shut-off cock; 3, T-connection; 4, trap made by coiling the rubber outlet tube on itself and securing it with adhesive plaster; 5, catheter passing through the wall of the perforated outer tube 7, which passes through the suprapubic opening and rests in the bladder; 6, Wolfe bottle for collecting the urine; 8, bottle in which tube 7, intended to carry off the urine in case the apparatus fails to work from blocking of the catheter or any other reason, terminates; 9, receptacle for discharges of water from apparatus.

The proper operating area in lithotrity is at or beyond the center of the cavity of the bladder; in opening the instrument after introduction, care must be taken that the male blade does not impinge against the vesical neck. When the stone is lodged in the neighborhood of the latter, however, this may be unavoidable. All movements of the manipulation must be executed smoothly, in order to avoid unnecessary jarring of the sensitive vesical neck.

The stone being seized, the button connecting the screw is locked and the latter gradually turned until a secure grasp is felt on the stone, which is then moved about in order to make sure that a fold of mucous membrane is not included. In a trabeculated bladder this may easily occur.

The crushing is now proceeded with. The stone, if hard, gives way suddenly under the grip of the instrument; if soft, it simply crumbles. In the case of an extremely hard stone the instrument is felt to spring as the male jaw is advanced. Unless the operator is an experienced lithotritist, such a stone should be removed by the suprapubic route.

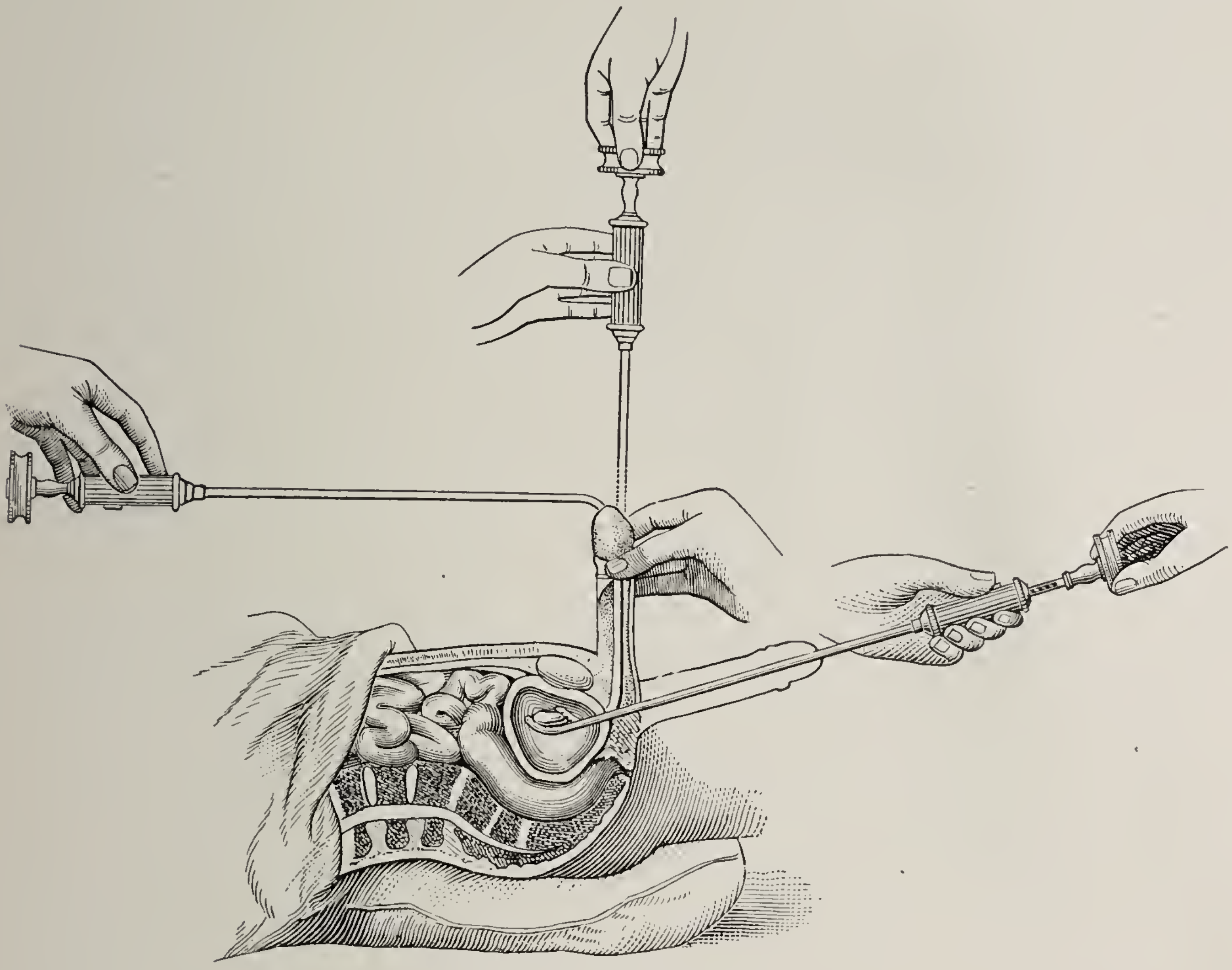

Fig. 625.—Lithotrity.

The fragments resulting from the first grasp fall close to the site occupied by the stone when it was crushed. By keeping the lithotrite in the original position and opening and closing its blades other fragments are successively seized and crushed. When considerable debris is formed, the instrument is closed and withdrawn.

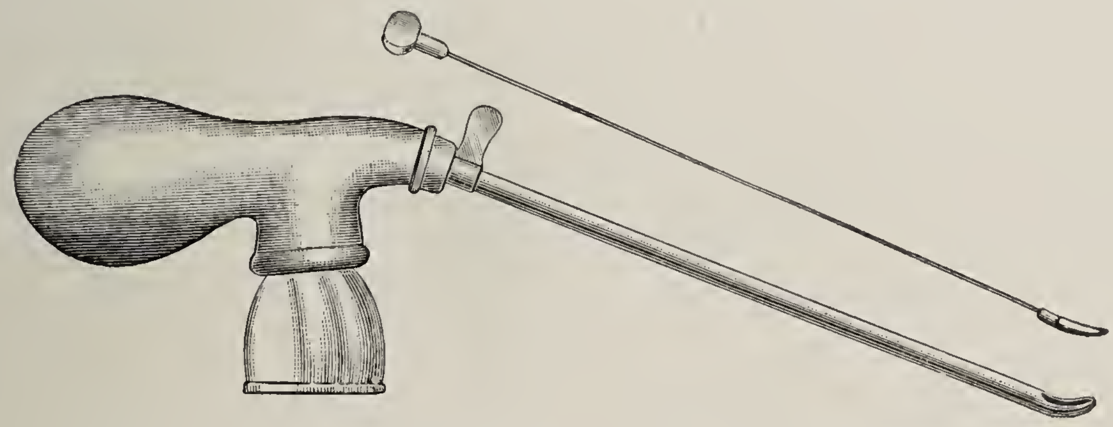

Fig. 626.—The Chismore Bladder Evacuator and Obturator.

The evacuating tube is then introduced and connected with the evacuator (Fig. 626); the latter is filled with warm boric acid solution. The washings are carried on by quickly and forcibly compressing the bulb so as to drive about two ounces of the fluid into the bladder, and then relaxing the pressure. The return flow of the fluid brings with it the crushed fragments. When no more debris is evacuated, and the presence of fragments is announced by the clicking of these against the evacuating tube during the washing, the tube is withdrawn, and the process of crushing followed by evacuation of the fragments repeated.

In the **after-treatment** the patient is kept in bed for a few days, placed on a liquid diet, and sufficient morphin is given hypodermically to relieve pain. If fever is present from 10 to 15 grains of salicylate of soda should be given. For the accompanying cystitis, urotropin in 5-grain doses every four hours is to be prescribed. If the urine is diminished in quantity, 15-grain doses of diuretin every three or four hours should be given. If the cystitis does not yield, the bladder is to be irrigated two or three times a day with warm boric acid solution. The bladder should be thoroughly washed out with the evacuator at the end of a week to insure removal of all fragments.

Treatment of Stone in the Bladder in the Female.—If the stone does not exceed three-fourths of an inch in diameter it may be removed by dilatation of the urethra. Larger stones are best dealt with by lithotrity or lithotomy. In performing the latter the surgeon has the choice of the vaginal route, which is seldom used at the present day on account of the dangers of vesicovaginal fistula, and the suprapubic route. The latter is available for all stones too large for removal by dilatation and too hard for crushing. In performing suprapubic lithotomy in the female, the air or fluid for distending the bladder is prevented from escaping by pressure with the finger against the urethral orifice.

Extra-vesical Urinary Calculus.—Urethral Calculus.—Urethral calculi are rarely formed primarily in the urethra. They are usually formed either in the kidneys or in the bladder and are arrested either at the prostatic sinus, the membranous urethra just behind the triangular ligament, the peno-scrotal angle, the fossa navicularis (points of physiologic narrowing), or behind a stricture. Several stones may coexist. Urethral calculi may escape through the meatus or remain for years without giving rise to serious trouble, slowly enlarging in the meanwhile; or they may produce ulceration, urinary fistulas, and spontaneous expulsion through the latter. They may completely or partially fill the urethra and produce retention, or incomplete obstruction, the urine dribbling away.

The **symptoms** vary greatly, from those due to sudden impaction and painful stoppage of the stream of urine to those of irritation and partial obstruction. If in the prostatic urethra or partially within and partially without the vesical neck, vesical tenesmus and irritability may be present.

The **diagnosis** is easily established. All parts of the urethra are accessible, either externally or through the rectum, for manipulation, and a sound passed through the urethra will determine the fact that a foreign body found in the urethra is calcareous.

The **treatment** consists of systematic attempts to expel the calculus by the patient's own efforts. This may be accomplished by the aid of an overfilled bladder, a hot bath, and a full opiate. The patient commences the act of urination, checks it suddenly by compressing the urethra, and, when the latter is distended and more room afforded for the passage of the stone, releases the urethral compression, at the same time making a vigorous expulsive effort (Keyes).

The above maneuver failing, resort must be had to **surgical** interference. This consists in attempting to force the calculus toward the meatus by manipulation; if soft, it is crushed *in situ,* by pressure from without; the fragments are washed out by the next flow of urine. A full-sized sound may be used to dilate the urethra; this, when suddenly withdrawn, is sometimes followed by an over-forcible propulsion of urine which may result in dislodgment and escape of the stone. A Thompson divulsor (Fig. 586, C) may be carried past the calculus, its blades separated and then closed again; the calculus falls between the blades and is grasped and withdrawn with the instrument.

Several **special instruments** have been devised for the removal of urethral calculi. Among the best are the alligator forceps, curved and straight (Fig. 586, A), and Leroy d'Etiolles's urethral scoop (Fig. 586, B). If deeply placed (posterior to the constrictor urethrae muscle) a stone in the urethra may be pushed into the bladder and dealt with subsequently by litholapaxy. Finally, an incision may be made directly down on it and the stone removed through the opening.

Stone in the Ureter.—This has its origin in the calices or pelvis of the kidney, and if of large size or irregular surface it becomes arrested in the ureter. The points where the stone is most frequently arrested are (1) the junction of the pelvis and ureter; (2) two inches below the above point; (3) at or near the pelvic brim; (4) in that portion of the ureter which passes between the muscular and the mucous coat of the bladder wall just before the tube terminates in the cavity of the bladder.

Morris, in a study of 12 cases in which the position of impaction was discovered post mortem, found the lower end of one ureter to be the seat of impaction in 5 cases, the upper end of the ureter in 3 cases, an inch or less from the vesical orifice in 3 cases; in one case three calculi were found in separate compartments of the same ureter. The position of impaction as found on operation in 45 cases was as follows: within two inches of the kidney, 19 cases; near the vesical orifice, 15 cases; near the level of the brim of the pelvis, 11 cases.

Multiple calculi may exist and both ureters may contain stones at the same time. The x-rays will prove of value in some cases in locating calculi in any of these positions.

The **general effects** of ureteral calculi are as follows: (1) those effects due to mechanic obstruction more or less complete; these are manifested by retention behind the calculus, interference with the function of the kidney of the same side, and, through the reflex effects of irritation, with that of the other side as well, total suppression of urine resulting; (2) with absolute stoppage the resulting hydronephrosis is followed by destruction of the secreting portion of the corresponding kidney; the other organ becomes hypertrophied and performs the functions of both; (3) with partial obstruction some urine escapes alongside the calculus; hydronephrosis is followed by inflammatory processes which finally lead to pyelitis; this is succeeded in turn by pyonephrosis and pyelonephritis. Chronic inflammatory and degenerative conditions of the kidney structure may occur (parenchymatous or interstitial nephritis); (4) severe and prolonged pain and consequent loss of sleep produce a condition of nervous exhaustion. The **local effects** are the following: (1) Stretching of the ureteral walls and inflammatory conditions which may lead to ulceration and perforation followed by abscess. These abscesses may find their way (*a*) along the postperitoneal connective tissue upward into the pleural cavity and finally through a bronchus, (*b*) downward into the pelvis and alongside the bladder, (*c*) posteriorly through the muscular structures, pointing on the surface of the back, (*d*) anteriorly into the peritoneal cavity, (*e*) into some portion of the intestinal canal. (2) Chronic inflammatory conditions with fibrous thickening of the walls of the ureter, and finally dilatation. With the occurrence of the latter the calculus may move on under the influence of accumulating pressure behind it and set up the same changes at another part.

The most characteristic of the **symptoms** of impaction of a calculus in the ureter is pain of a severe and lancinating character, felt in the side, back, and abdomen, shooting downward toward the bladder, scrotum, and thigh, and accompanied by frequent desire to urinate, and nausea and vomiting. The severe pain occurs in paroxysms; as the stone is forced along the ureter it is most severe, abating as it comes to a standstill, and persisting, particularly in the renal region, with more or less severity as long as the ureter is blocked. With the occurrence of inflammatory conditions fever will be present. With the supervention of suppuration, a characteristic temperature curve will be observed.

The **diagnosis** at the commencement is that of simple renal colic. With persistent return of the symptoms, and perhaps the existence of more or less disturbance in the interval, impaction should be suspected. The urine should be examined for blood and albumin and later for pus cells. The total quantity for twenty-four hours should be saved, that from each micturition in a separate glass, to avoid error. Obstructive lesions of the bowels are to be eliminated. Palpation through the vagina in the female may assist in establishing the diagnosis. In the male only the last three-fourths of an inch of the ureter is accessible to the finger in the rectum. In lean patients a large stone may be felt through the abdominal wall. A constant tender spot in the course of the ureter is a suspicious circumstance. X-ray examination may show the situation of the stone, particularly in the case of oxalate and phosphate stones. The occurrence of hydronephrosis or pyelonephrosis following an attack of renal colic may be due to impacted stone or to a movable kidney with angulation of the ureter. Finally, exploratory laparotomy is to be recommended. Ureteral catheterization with a wax-tipped catheter has been successfully employed. The roughened surface of the stone leaves scratches on the wax (Kelly).

The **treatment** may be divided into the purely medical, and the surgical treatment. The first includes morphin administered hypodermically for the relief of pain, and a general anesthetic in urgent and exceptionally severe attacks. Hot local applications and hot baths are useful to relieve spasm and facilitate the passage of the stone. Diuretics and specially the use of large quantities of water, are sometimes indicated. Cupping, followed by hot fomentations over the kidneys, is to be employed to increase the action of the latter. The salts of lithia and piperazin are to be administered during the intervals of comparative rest.

The presence of a stone that will not pass constitutes the indication for **operative treatment.** The febrile indications of suppuration may be present; there may be constantly returning hydronephrosis; pyonephrosis may occur; decided diminution of the amount of urine which reaches the bladder or even anuria may result before the surgeon feels justified in operating. The symptoms of progressive degeneration of the renal structure should be watched for. Repeated examinations of the urine should be made; the obstruction may be complete at times and at other times not.

In carrying out the **operative technic of ureterotomy** an endeavor is to be made to reach the ureter by an extraperitoneal route. In case the calculus is lodged near the pelvis of the kidney, it may be reached by opening the latter and passing a long forceps through the dilated portion. The entire length of the ureter except the last three inches, and even this in children, can be reached by an incision, which, commencing at the lower border of the twelfth rib on the anterior edge of the iliocostal mass of muscles, is curved parallel to the rib to its tip, thence downward toward the middle of Poupart's ligament to a point about two fingerbreadths above the latter, from which point the cut is carried toward the median line, terminating at the outer edge of the corresponding rectus muscle. The dissection is carried down to the peritoneum and the latter is stripped up with the fingers (Israel). The ureter adheres to the peritoneum and is lifted up with it. The peritoneum is adherent to the spine near the point where the ureter approaches the latter, and this fact is of service in the search (Cabot). On the right side the vena cava and ureter lie in close apposition, the vein being between the tube and the spine.

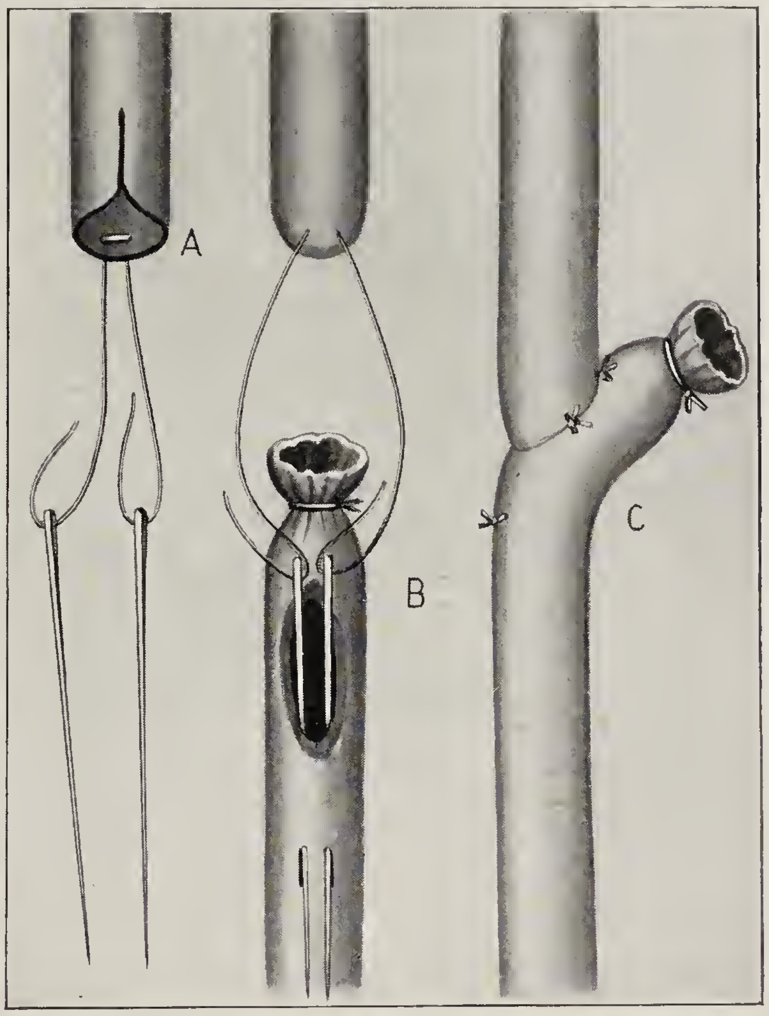

Fig. 627.—Van Hook's Method of Lateral Implantation of the Ureter.

A, The renal portion of the ureter split longitudinally, the ends trimmed so as to admit of easy implantation, and the loop of catgut passed; B, showing the method of passing the needles so as to draw the renal portion into the vesical portion; C, the implantation completed.

The last two or three inches of the ureter may be reached through a median abdominal section. Finally, the removal of a portion of the sacrum after Kraske's method in carcinoma of the rectum (see page 133) will give access to the lower portion of the ureter, the impacted stone serving as a guide.

After the ureter has been incised and the stone removed, the opening in the ureter may be closed by a continuous suture (Lane). If this cannot be done easily, it will be better to sever it completely just above the point of opening, ligate the end of the distal portion, and make a lateral implantation of the renal portion into the vesical portion (Van Hook). Two straight needles are threaded with a single strand of fine catgut and passed through the entire thickness of the proximal end of the tube which has been previously trimmed and split for a short distance. This thread forms a "bight" by means of which the tube is firmly grasped (Fig. 627, A). The needles are now passed into the interior of the ureter through the lateral opening, the length of which should be equal to twice the diameter of the ureter, made for the removal of the stone, and they should be made to emerge by perforating the wall a quarter of an inch or more below (Fig. 627, B). By withdrawing the needles and pulling the strands of catgut after them, at the same time guiding the proximal end into the lateral opening, the proximal end is drawn into the distal end, where it is secured by a few fine catgut sutures which attach the edges of the lateral opening to that part of the wall of the distal portion which it incloses. The ends of the loop of catgut are now tied together so as to form a suture (Fig. 627, C).

The same method is employed in cases of **accidental injury of the ureter.** If loss of substance prevents the application of Van Hook's method, end-to-end approximation may be employed, the ends being cut obliquely so as to avoid a circular scar (Bovee and Tietze).

THE PROSTATE

The following **anatomic points** should be borne in mind in connection with the surgery of the prostate:

The organ is situated at the neck of the bladder, and embraces the first one and one-fourth inches of the urethra. The intraprostatic portion of the urethral canal becomes more or less distorted when enlargement takes place and is sometimes more than doubled in length. In the normal condition that portion of the prostate situated behind the urethra is much thicker than that in front; in the latter the gland tissue may be wanting entirely, its place being supplied by circularly placed unstriped muscular fibers continuous with those surrounding the membranous urethra in front and the muscular wall of the bladder behind. The organ is an accessory portion of the urethra, to which it is inseparably attached. It is divided into two **lateral lobes** by a deep notch behind, and a median groove in front, the latter corresponding to the uvula vesicae. That portion lying between the lateral lobes below the neck of the bladder and at the posterior and inferior part of the gland is sometimes called the **middle lobe.** In the normal state it is entirely extravesical, no portion of it projecting on the bladder surface. The glandular structure itself is composed of a number of follicles lined with columnar epithelium; these empty by a number of excretory ducts in the floor of the prostatic urethra near the center.

The relations of the prostate to the sphincter muscular apparatus at the vesical neck are of importance from the surgical standpoint. Three sets of muscular fibers demand notice: (1) the thicker portion of the circular muscular coat of the neck of the bladder and the vesico-urethral orifice; (2) the intrinsic muscular fibers of the prostate (Cuthbert S. Wallace); (3) the compressor urethrae and the upward extension from the latter of a layer of circular muscular fibers which embraces the apex of the prostate. The first and second layers are unstriped; the third is the most important.* Though the normal prostate has a thin but well-defined proper capsule distinct from that derived from the rectovesical fascia, the firm fibrous envelop which the gland presents under certain conditions of enlargement is wanting in health. In an adenomatous prostate the true capsule is reinforced by a cortical layer derived from the gland itself by a process of compression by the adenomatous growths. In addition to this, that derived from the rectovesical fascia forms an outer fibrous sheath (Deanesley). The prostatic plexus of veins lies between these two.

A small muscular bundle, the superficial anobulbar raphe, passes from the posterior extremity of the bulb to the anus. When this is divided and the bulb lifted forward, the anterior edge of the levator ani on each side and a band of muscular fibers lying in the middle line between the latter and uniting the membranous urethra to the rectum (the rectourethral muscle of Proust) are brought into view. This is the key to the rectovesical space.

Injuries of the prostate are very rare. Wounds of this organ sometimes occur in penetrating wounds of the perineum. Unless these extend beyond the capsule and give rise to pelvic cellulitis and peritonitis, they are of minor importance as compared with the more serious injuries of the urethra or rectum which accompany them.

Inflammation of the Prostate.—**Acute prostatitis** is usually the result of a posterior urethritis of gonorrheal origin and is generally due to exposure to cold, sexual excitement, alcoholic excesses, and instrumentation of the deep urethra. It is usually ushered in by a chill, with an increased sense of fullness in the perineum, vesical irritability, burning pain during micturition, and acute pain at the end of the act. Defecation is also painful. Irregular fever and repeated chills mark the course of the disease. The attack may end in resolution or in the formation of an abscess. Digital examination by the rectum reveals the prostate enlarged and exquisitely tender. A softened area may be made out, surrounded by the hard, edematous tissues of the prostate, marking the site of an abscess. In case of the latter the dysuria is increased and retention may occur. Rupture usually takes place into the urethra during urination or defecation. Occasionally the purulent focus points in the direction of the bladder and opens into the latter. Still more rarely rupture into the rectum takes place. Rupture into the urethra and rectum may both occur, a urethrorectal fistula resulting. Finally, the purulent focus may point downward and infect the periprostatic connective tissue.

Chronic Prostatitis.—This may follow an acute attack or it may occur without appreciable cause. The symptoms vary greatly. There is usually some irritation and a sense of fullness in the rectum. In more pronounced cases there is pain, heat, and throbbing in the perineum in addition. There may be a sense of weight in the pubic region and about the penis and scrotum, with pain referred to the urethra and the glans penis.

Treatment.—This consists, in acute cases, in hot perineal and suprapubic applications, hot rectal irrigations with a double tube, and anodynes by the rectum. When due to gonorrhea, balsamics and urotropin are to be employed internally; all local treatment for the gonorrhea is to be abandoned. Retention is to be relieved by the catheter when practicable, otherwise perineal section is to be resorted to. The patient should remain in bed during the acute stage. Careful watch must be kept for the formation of pus, and this must be evacuated early, and in the direction of the perineum, whenever possible. In chronic cases the hot rectal douche is useful. Every effort to avoid congestion of the parts about the vesical neck should be made. Further than this the treatment of chronic prostatitis is the treatment of the accompanying chronic posterior urethritis.

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* According to Henle, the muscular structure of the prostate furnishes the effective sphincter action in the control of the bladder contents. The preponderance, however, of nonstriated fibers and fibrous tissue as the urethra is approached, the absence in the female of similarly placed muscle-fiber surrounding the urethra, and, finally, the fact that practically the entire prostate can be removed without loss of control of the bladder, militate against this.

Periprostatic Cellulitis.—This may result from a prostatic abscess, wounds through the rectum, suppurative vesiculitis, and tuberculous disease. Cancer of the prostate or base of the bladder, and also suppuration of one of the lymphatic glands between the prostate and the rectum, may give rise to periprostatic cellulitis simulating prostatic abscess. The purulent collection advances in the direction of the perineum and the ischiorectal fossa; it may finally discharge into either the urethra, the rectum, the ischiorectal fossa, or the perineum. The urethrorectal fistula which results from a rupture into both urethra and rectum is usually most intractable in healing without surgical aid. The occurrence of suppuration in the retroprostatic layer of cellular tissue renders possible infection of any connective-tissue plane in communication with this layer (Guyon), the pus burrowing as high as the umbilicus or even to the ribs. The treatment consists of rest in bed, hot rectal douches, and anodynes and laxatives. Retention requires the use of the soft catheter. The formation of pus is shown by increase in the symptoms, chills, etc. Fluctuation may be detected at or near the prostate; exploratory aspiration will reveal the presence of pus. This should be evacuated early, preferably by a free prerectal incision of the perineum. In some cases the focus points in the direction of the rectum, with adhesions present. These will require incision by the rectal route.

Subacute Prostatitis.—This has for its chief symptoms a slight, tenacious, glairy discharge from the urethra, which makes its appearance specially after unusual sexual activity or excitement, or when other reasons exist for irritation or congestion of the deep urethra. This discharge is the result of an undue activity of the glands communicating with the prostatic urethra (**prostatorrhea**).

The **treatment** consists of tonics, outdoor exercise, the avoidance of sexual excitement, and the use of an occasional deep urethral astringent application, such as two drops of a 5 per cent solution of nitrate of silver, a 1 or 2 grain to the ounce solution of sulfate of copper or a 3 per cent to a 12 per cent solution of sulfate of thallin. The occasional use of the steel sound is of benefit in some neurotic cases. Massage *per rectum* is of service in cases in which the above measures fail to afford relief.

Tuberculous prostatitis as a primary affection is comparatively unknown. It may be secondary to tuberculous disease of the testicle; more frequently, however, it follows tuberculosis of the kidney or bladder. The **symptoms** at first resemble those of acute prostatitis; later on they suggest vesical calculus, which must be excluded. Finally, caseous masses and tubercle bacilli may be found in the urine. **Cystoscopy,** if attempted, will require general anesthesia. The prognosis is exceedingly unfavorable. In the **treatment** the instillation of a 1 to 5 per cent solution of nitrate of silver is of temporary benefit. In the rare event of the absence of a renal or bladder tuberculous complication, perineal section and thorough curetment, and cauterization, may be tried.

Prostatic calculi are sometimes met with. The nucleus is usually inspissated secretion which finally becomes covered with repeated phosphatic deposits. A number of these may collect in the sinus. The **symptoms** simulate those of vesical calculus. The differential diagnosis depends on the fixed position of the stone with the different movements of the bladder. This is confirmed by palpation with a sound in the bladder and the finger in the rectum. The sound will sometimes push the calculus into the bladder. The **treatment** is by extraction *per urethram* with urethral forceps when small, and by perineal incision when large and fixed.

Hypertrophy of the Prostate.—About 30 per cent of men who have passed the fiftieth year have some degree of enlargement of the prostate. About one out of four of these suffer pronounced bladder symptoms due to the presence of the disease. It is seldom manifested before forty-five or after seventy. Though the enlargement probably commences at a much earlier period, the vesical disorder which attracts attention rarely appears before the period between the fiftieth and the sixtieth year. The causes of this peculiar condition have not as yet been determined.

The **morbid anatomy** consists in hypertrophy of all the elements of the gland, the epithelial elements predominating (adenomatous hypertrophy). Distinct nodules are seen on section. As a result of inflammatory changes the adenomatous prostate becomes replaced by fibrous tissue (fibrous hypertrophy). The hypertrophy may involve any or every part of the organ. The most commonly observed changes occurring in connection with prostatic hypertrophy are (1) projection of the posterior surface of the gland from hypertrophy of the lateral lobes; (2) elevation of the vesico-urethral orifice; (3) production of a middle lobe; (4) lengthening and distortion of the prostatic urethra.

Lateral Hypertrophy.—The lateral lobes are involved in this form of hypertrophy. The enlargement may be such that its upper border cannot be reached by the examining finger in the rectum. This form of enlargement occurs in a large proportion of cases of hypertrophy of the prostate. One lobe may be more hypertrophied than the other or the gland may be felt as a somewhat symmetric globular mass. When the hypertrophy is confined to the lateral lobes, a sulcus may sometimes be felt at the site of the posterior commissure with a bar stretching across (see page 316).

Elevation of the Urethral Orifice.—This occurs to a greater or lesser extent in every form of prostatic hypertrophy. In general hypertrophy the urethra is crowded upward into the bladder, simulating the so-called **bar at the neck of the bladder** (see page 316). Elevation of the urethral orifice may be caused by contracture of the neck of the bladder the result of chronic posterior urethritis occurring in the course of prostatic hypertrophy. The third or middle lobe also causes elevation of the urethral orifice. The use of the term "third lobe" should be limited to designate an outgrowth having its origin in the accessory prostatic glands which lie at the urethral orifice just under the circular fibers of the bladder and the middle isthmus of the prostate. More or less median enlargement is present in more than three-fourths of the cases of prostatic hypertrophy.

Alterations in the length, size, and curve of the prostatic urethra occur in prostatic hypertrophy. Lengthening is an invariable accompaniment of all forms of the disease, particularly in cases of middle lobe or prostatic bar. Dilatation is present where the lateral lobes are involved, the canal being altered in shape from a transverse to a vertical slit. Lengthening of the curve of the urethra results from elevation and backward displacement of the internal orifice, necessitating, in case of retention, the use of an instrument with a curve of much longer radius than that ordinarily employed. The urethra is also deformed by tumors projecting into it from the middle lobe or the lateral lobes.

Symptoms.—A desire to urinate more frequently than normal, particularly at night, is usually the first symptom of hypertrophy of the prostate. This **nocturnal frequency of urination** is due to congestion of the bladder and prostate and consequent increased sensitiveness of the parts, and is almost pathognomonic of this disease. This may or may not be accompanied by nocturnal polyuria. The latter, when present, is uniformly distributed throughout the night, while the former is increased in the early morning hours.

Difficulty of urination, or **dysuria,** results from prostatic obstruction. The stream of urine lacks force, straining efforts tend to lessen rather than to increase the force of the stream, and the act terminates in a series of weak, irregular jets and drops. **Pain** on urination and general uneasiness in the interval vary greatly, according to the amount of congestion and inflammation present.

Catarrhal inflammation of the vesical neck leads to increased desire to urinate and the patient is made aware that the bladder is not completely emptied. The urine now begins to undergo changes; it becomes cloudy and a deposit of pus in the glass is noticed. With the increase of residual urine the sphincter vesicae may relax under the intravesical pressure and some urine passes involuntarily. It frequently happens that the patient does not seek advice until this or a severe cystitis or even complete retention has occurred. The latter may be precipitated by some error in diet, a chill, or some unusual exertion. Finally, chronic cystitis is established; this may be subject to acute exacerbations.

Complications.—The complications of hypertrophy of the prostate are (1) inflammation of the prostate, usually due to catheterism; (2) abscess and periprostatitis; (3) seminal vesiculitis. Epididymitis may be due to instrumentation or occur during an acute attack. Chronic epididymitis is sometimes present, as shown by a thickening at one end of the epididymis. Cystitis is commonly present. It may be due to catheterism, in which case it begins acutely, often with a chill. When spontaneous, it is usually chronic from the commencement, as a rule, and is mild throughout. This so-called catarrh of the bladder is characterized by alkaline urine with an ammoniac odor. Occasionally the urine is acid and yet ammoniac from mingling with the ammoniac residual urine. The urine is cloudy, with floating shreds, pus, and ropy mucus. Amorphous urates and phosphates and triple phosphates are usually present. Exceptionally severe acute cystitis and pericystitis may be present. Pyelonephritis results from urinary stasis and bacterial infection. Phosphatic calculi result from protracted ammoniac cystitis. These may be present for a long time without aggravating the already existing symptoms.

Diagnosis.—The first point in diagnosis relates to the age of the patient. If he is over forty-five and gives a history of the above symptoms in whole or in part, prostatic hypertrophy should be suspected. In verifying this suspicion the following methods of examination are employed:

1. **Examination per rectum.**—The size of the prostate, as well as its consistency, is noted. When enlarged, it is usually firmer than normal. Even when these two conditions are markedly present the prostate may not be the cause of the trouble. An examination by means of the sound may give some idea of the condition of the urethral surface, for it is here that the changes in the organ occur that give rise to the obstruction. The use of the cystoscope does not give material aid and may be injurious.

The crucial test, however, consists in the demonstration of the presence or absence of **residual urine.** The patient is requested to pass his urine in the upright position. The act being completed, he is placed on his back and a soft catheter is passed. A flow of urine follows, which, if it exceeds two ounces, is to be regarded as evidence that voluntary evacuation of the bladder is incomplete.

The possibilities of the presence of stone in the bladder, of vesical catarrh and of tumor (including cancer) or tuberculosis of the bladder, are to be taken into account. Renal calculus is not to be lost sight of in the diagnosis. Finally, the patient should be examined for stricture of the urethra.

The condition of the kidneys is now to be inquired into. The daily excretion of urea is to be estimated, the presence of albumin in the urine, as well as the presence of casts and their character, is to be ascertained. Contracted kidney may be present with a large quantity of secretion; hence the necessity for careful quantitative analysis, though the low specific gravity will always suggest an incompetency of the renal organs.

Finally, the patient's general condition is to be investigated. Cardiac and liver disease may further complicate the case and arteriosclerosis from chronic endarteritis may coexist.

The prognosis will depend on the extent of the resulting and complicating conditions. When once the patient has the normal emptying of the bladder under his control by means of the catheter, other things being equal, he may live for years.

Treatment.—Proper hygienic measures must be instituted as soon as the existence of prostatic hypertrophy is discovered. Everything tending to produce congestion of the pelvic organs must be avoided, such as exposure to cold and drafts, wet feet, the use of beer and champagne, and constipation. All excesses, mental, physical, and sexual, are to be avoided. Whisky, gin, and white wine in moderation may be allowed. The urine is to be kept bland by the plentiful use of water. The diet must be light. Meat is to be eaten sparingly, vegetables predominating in the dietary. Strawberries and other acid fruits are to be forbidden. Asparagus should be avoided.

General Treatment.—This includes remedies to control the congestion at the vesical neck, of which the tincture of the chlorid of iron in 10-drop doses t. i. d. and urotropin, from 8 to 15 grains t. i. d., are the best. The dysuria usually depends on the cystitis, which should receive appropriate treatment (see

Cystitis, page 303). In addition to the local treatment the administration of liquor potassae and the preparations of hyoscyamus will be useful. All medicines not well borne by the stomach should be discontinued at once. Opiates should be avoided as much as possible.

Local Treatment.—During the first stage of the disease local treatment should be directed toward the relief of pain about the vesical neck, for which suppositories containing hyoscyamus, and as a last resort opium, may be prescribed. **Acute retention** must be treated by hot sitz-baths and the hypodermic use of morphin. These failing, with increasing distention the bladder must be emptied by the catheter. The rubber or silk woven catheter, thoroughly cleansed, must be passed after the anterior urethra has been irrigated, and the bladder must be evacuated slowly. It may be necessary to employ one of the long curved silver prostatic catheters (Fig. 628, A). The utmost care is to be used in passing a metal instrument and the dilated prostatic urethra borne in mind. Finally, aspiration must be resorted to. If, after aspiration at intervals of eight hours for a day or two, catheterization is still impossible, operation must be resorted to.

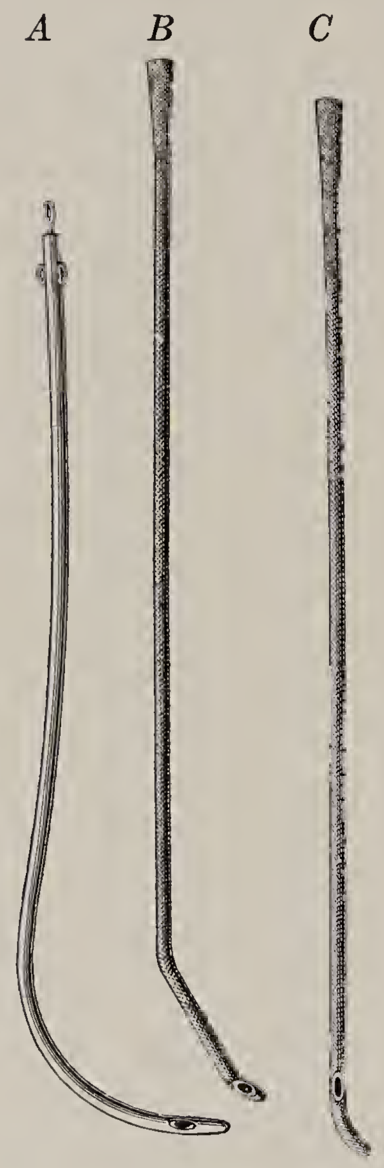

Fig. 628.—Prostatic Catheters.

A, Large curved metallic catheter; *B*, Mercier's bi-coudé catheter of woven silk; *C*, Mercier's coudé catheter.

In the second stage retention is to be relieved by catheterization (*vide supra*) when necessary and the evil effects of residual urine guarded against. If the latter does not exceed from two to four ounces, catheterization every evening will suffice. From four to six ounces of residuum requires a twice daily use of the catheter. The systematic use of the catheter in a gentle and cleanly manner without undue frequency, is most important. The bladder should be irrigated after each catheterization with boric acid solution and urotropin administered internally. This systematic use of the catheter is the initiation of the so-called **catheter life.** The patient is to be fully instructed in every detail of the use of the catheter, including methods of cleansing, sterilization, and preservation. Washing it under the running water tap, boiling it for ten minutes, and storing it in a clean metal box or between the folds of a clean towel suffices. The lubricant should be sterilized and kept in a collapsible tube. The patient should not neglect to wash his hands with soap and water each time before catheterizing himself.

Infection of the bladder and posterior urethra must be guarded against and must receive appropriate treatment when present. Balsamics and alkalis are to be given internally, and the stronger injections, such as nitrate of silver (1:2000 to 1:1000 solution daily or on alternate days, or even stronger, if well borne) and protargol (0.5 per cent to 10 per cent solutions), employed. These should be used by slow injection or instillation, not by irrigation. In acute inflammatory, as well as in irritable conditions, it is sometimes best to abandon local medication and rely on catheterization, anodynes, and rest in bed.

In **obstructive cases** the passage of a sound to relieve spasm of the cut-off muscle before catheterization is useful. The retained or permanent catheter may be used to advantage in this class of cases. The most perfect cleanliness must be observed and the catheter changed every day or two. When the bladder is contracted or irritable, **overflow** occurs. If catheterization, irrigation, and the permanent catheter fail to relieve this, then the patient must either submit to operation or wear a urinal.

The occurrence of **false passages** is shown by pain during catheterization and bleeding after the withdrawal of the instrument. Suprapubic aspiration, hot sitz-baths, and rest of the parts are proper measures for these cases in the beginning. With persistence of the obstruction and failure to reach the bladder with a soft-rubber catheter, perineal section and drainage must be resorted to (see page 269).

The Operative Treatment of Prostatic Hypertrophy.—Palliative treatment failing, operative treatment must be resorted to. This may be divided into (1) palliative operations; (2) radical operations.

Palliative Operations.—These include **suprapubic aspiration** and **suprapubic cystotomy.** Suprapubic aspiration is employed only as a temporary palliative measure and its use is usually restricted to cases of acute retention. Suprapubic cystotomy or the formation of a fistula in the bladder wall above the pubes has been heretofore employed in cases of prostatic hypertrophy to establish permanent drainage in the attempt to relieve the suffering due to chronic cystitis. The relief which it affords is scarcely worth the inconveniences and discomforts which it produces. At the present time its use is restricted to cases in which temporary relief is to be afforded in order to gain time to restore the patient's strength for a radical operation (for operative technic, see Suprapubic Lithotomy). **Perineal drainage** has been used with good results. A rubber tube of large caliber (five-eighths of an inch) is employed and its use continued for six weeks. Complete relief of all the symptoms for several years has been obtained by this method.

Radical Operations.—These include (1) those designed to cause atrophy of the growth by interfering with its nutrition; (2) operations on the prostate, other than excision; (3) galvano-prostatotomy; (4) prostatectomy. Among those designed to cause atrophy may be mentioned iliac ligation (Bier), castration (White), and vasectomy (Harrison). Iliac ligation is of questionable utility. Castration does not cause atrophy, but does relieve the symptoms in some cases by relieving the congestion of the gland (Albarran), and hence is specially applicable in cases in which acute retention or congestion occurs. Its effects, however, are more or less ephemeral (Cabot) and the operation cannot be considered a radical cure. Even less can be said in favor of vasectomy.

Prostatotomy.—Incisions of the prostate are best made, in order to prevent their healing, by means of specially constructed galvanocautery instruments (Bottini, Freudenberg, Chetwood). General anesthesia by means of chloroform or nitrous oxid is to be employed. All aseptic precautions are to be taken, the bladder irrigated with boric acid solution, and about four ounces of the solution allowed to remain in the bladder, if Bottini's procedure is employed. The instrument is to be tested before introduction. During the operation a stream of cold water flows through the instrument. The street current, with a transformer and motor, is best employed to furnish the electricity. One or more incisions are made in the prostate. A permanent catheter is required for from three to seven days. The patient does not show the full benefit for four or five days, at which time the sloughs are cast off.

Chetwood modified Bottini's operation by making the incisions through a perineal cystotomy, after locating the obstructing lobes with the fingers, and cauterizing these to the extent necessary to lower the urethral orifice. Prostatectomy may be added, if indicated.

Prostatectomy.—In certain aggravated cases complete or partial **enucleation of the prostate** is indicated. The **suprapubic or intravesical method** (Fuller), it is claimed, will enable the operator more readily to detect the presence of stone and to outline the tumor to be attacked. A suprapubic cystotomy is first performed. The mucous membrane over each presenting lobe is incised and the latter is more or less easily shelled out by the finger, aided by a finger in the rectum (Freyer). The operation is better adapted to the adenomatous than to the fibrous variety of enlarged prostate. The rectovesical sheath is opened, which may lead to septic pelvic cellulitis. The subsequent drainage is effected against gravity and may

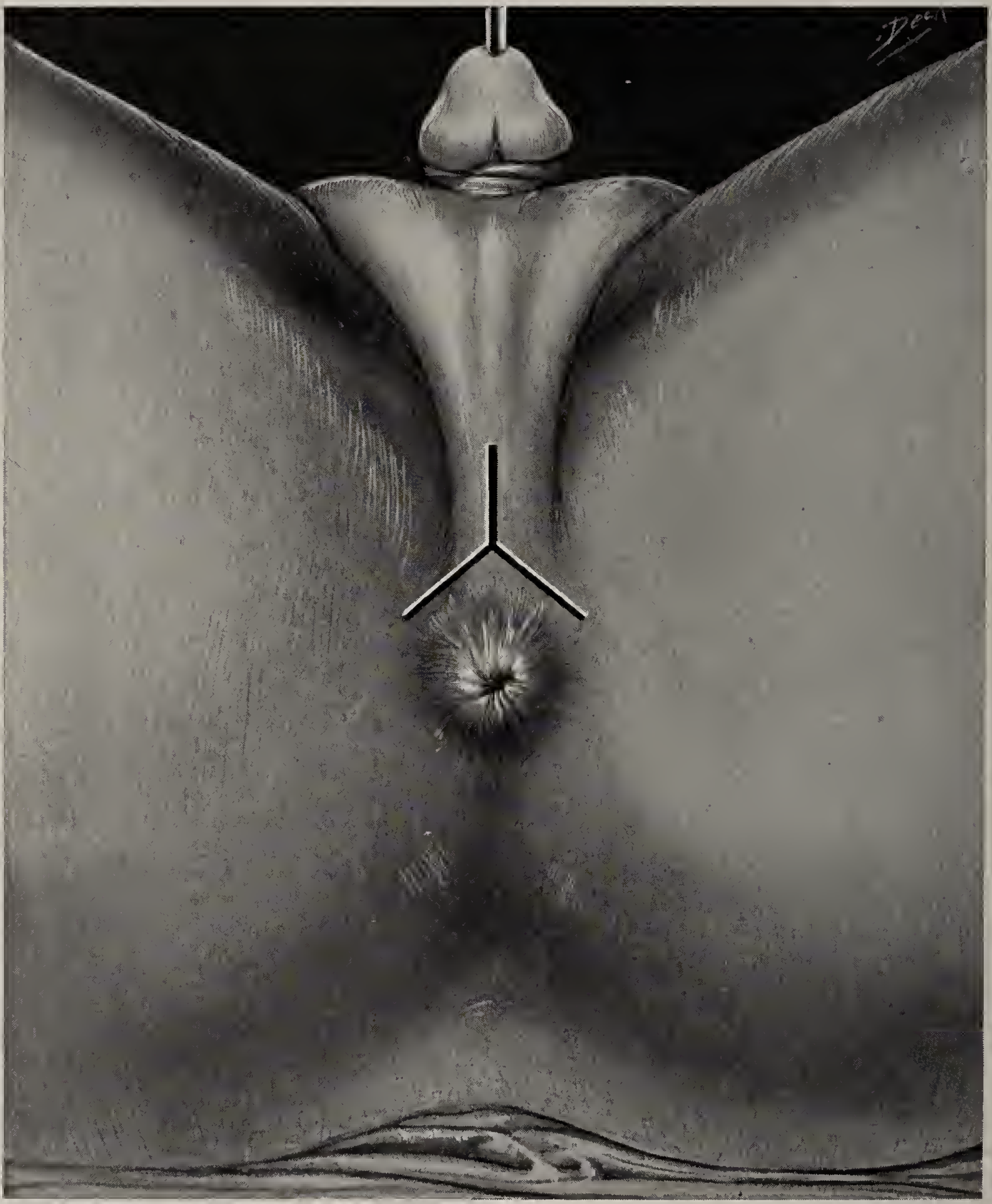

Fig. 629.—The λ-shaped Incision for Perineal Prostatectomy, with the Combined Grooved Staff and Prostatic Depressor in Position.

become a source of trouble. Irrigation with hot saline solution at the close of the operation is used to control the hemorrhage, which is likely to be profuse. Gibson's double suprapubic tube is employed for post-operative drainage.

The Perineal Method of Prostatectomy.—The patient is placed in the exaggerated lithotomy position until the perineum is almost horizontal and a grooved staff is placed in the bladder. A vertical incision is first made, extending from the bulb to within three-fourths of an inch of the anus. From the lower extremity of this incision two oblique incisions are made, extending in the direction of the tuberosity of the ischium of each side, these forming the λ incision (Fig. 629). Or the Λ incision of Young, the simple vertical raphe incision, or the curved transverse incision (the prerectal incision) may be employed. The skin and fat are dissected back until the bulbocavernosus and the ischiocavernosus are exposed. The superficial anobulbar raphe is put on the stretch and divided transversely and the bulb retracted upward and forward. This brings the anterior edges of the levator ani muscle on each side into view with the rectourethral muscle uniting the membranous urethra to the rectum exposed and defined. This latter muscle is the key to the rectovesical space (see page 331), and, when divided transversely, the latter is entered and separated as far as the peritoneum. The membranous urethra is now opened on the grooved staff, and the latter withdrawn. The anus and the rectum are retracted backward, thus exposing and dragging down the posterior surface of the prostate. In case the organ is deeply situated it is brought within reach of the operator by means of Ferguson's prostatic depressor, which still further depresses the gland and pushes it well down into the perineum. Or the combined grooved staff and prostatic depressor may be used (Fig. 630). The capsule is now opened by two vertical incisions (Fig. 631) and the prostate enucleated peripherally with the finger, the gland being left attached to the prostatic urethra. The enucleation is facilitated by grasping each lobe in turn with stout tenacula forceps. The prostatic urethra is now incised along its floor as far as the neck of the bladder, and, the depressor having been removed, the finger is inserted through the opening and into the urethra, steadying the latter; as each lateral half of the prostate is cut away with scissors, more or less of the floor of the prostatic urethra is removed as well. The upper wall of the urethra and the anterior commissure of the gland are left behind. A drainage-tube is introduced into the bladder, cavities left by the removal of the prostatic lobes tamponaded with gauze, and the perineum closed with silkworm-gut.

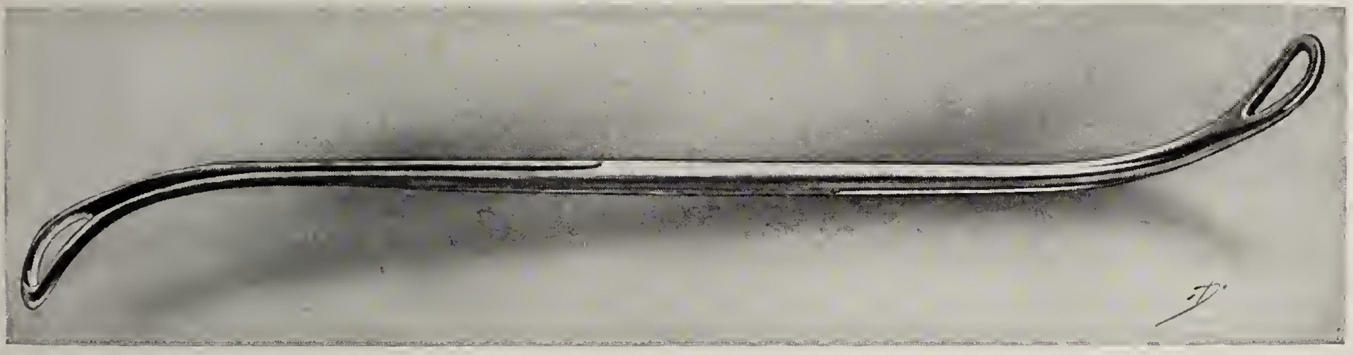

Fig. 630.—Combined Grooved Staff and Prostatic Depressor.

Parker Syms employs an inflatable rubber bag introduced into the bladder through the perineal wound, on which traction is made to bring the prostate within reach. Young's prostatic tractor is designed to effect the same object (Fig. 632). The same end may be accomplished by opening into Retzius's space above the pubes and forcing the vesical neck and prostate into the perineum by two fingers introduced at this point (Bryson, Guitéras). These expedients are unnecessary in the great majority of cases.

In the **Nicoll-Alexander method** suprapubic cystotomy is first performed. The bladder and prostate are explored with the finger and the membranous urethra opened on a staff from just behind the bulb to the apex of the prostate. The prostate is then brought within reach by means of two fingers of the left hand passed through the suprapubic wound, and the enucleation proceeded with by means of the forefinger of the right hand; this is begun at the posterior and inferior surface, at which point the sheath of the prostate is opened and the capsule entered. The mucous membrane of the prostatic urethra and the bladder are not opened. The lateral lobes are removed first. The entire opera-

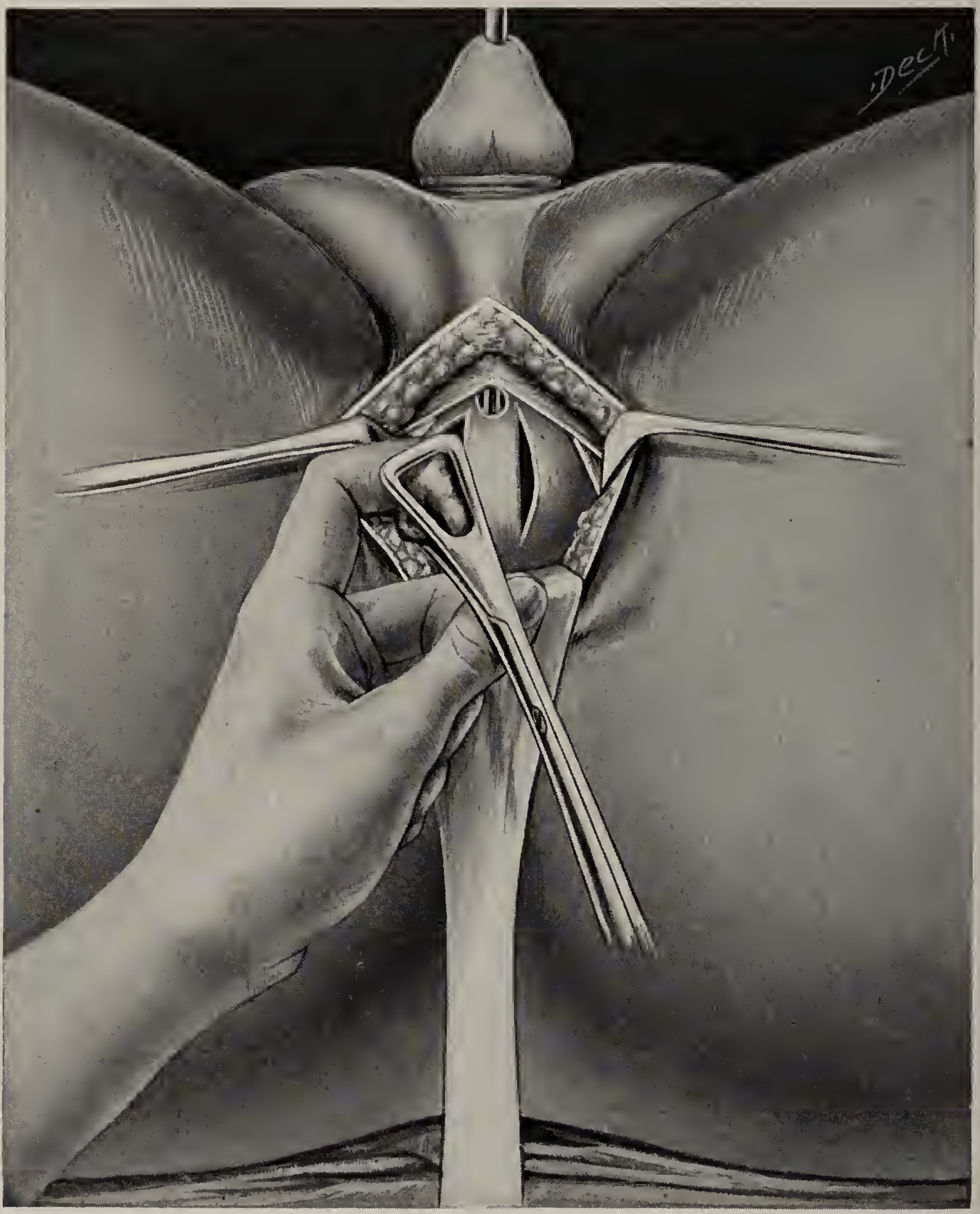

FIG 631.—PERINEAL PROSTATECTOMY.
The prostatic depressor is shown in position, the capsule well exposed, and the prostate in process of enucleation by the finger through the vertical incisions.

tion, after the urethra is opened, is performed by blunt dissection with the finger. Combined suprapubic and perineal drainage are employed for a week or more.

Intracapsular Perineal Resection (Partial Perineal Prostatectomy of Rydygier).—This procedure has for its object the accomplishment of the end with as little disturbance of the economy as possible. This is necessary in view of the fact that prostatectomy, as a rule, is demanded in more or less infirm elderly men. The median anteroposterior, or raphe incision, extending from the scrotum to the neighborhood of the anus, is employed. The prerectal arched incision (Zuckerkandl) or the ⅄ incision (Fig. 629) may also be employed. The capsule is split laterally, to an extent corresponding to the indications in the particular case. Neither the urethra nor the bladder is opened. Accidental opening of the urethra is guarded against by leaving the portion of the prostate next to the urethra. This precaution is made necessary by the fact that the prostatic urethra does not possess distinct walls exclusive of its mucous membrane. Injury of the ejaculatory ducts is avoided by leaving the portion of the prostate adjoining the urethra intact, so that the sexual function is conserved; incontinence of urine is said to follow less frequently.

A part of the benefit derived is probably due to subsequent cicatricial contraction. The operation is contraindicated in cases in which the enlarged median lobe forms the exclusive obstacle to urination.

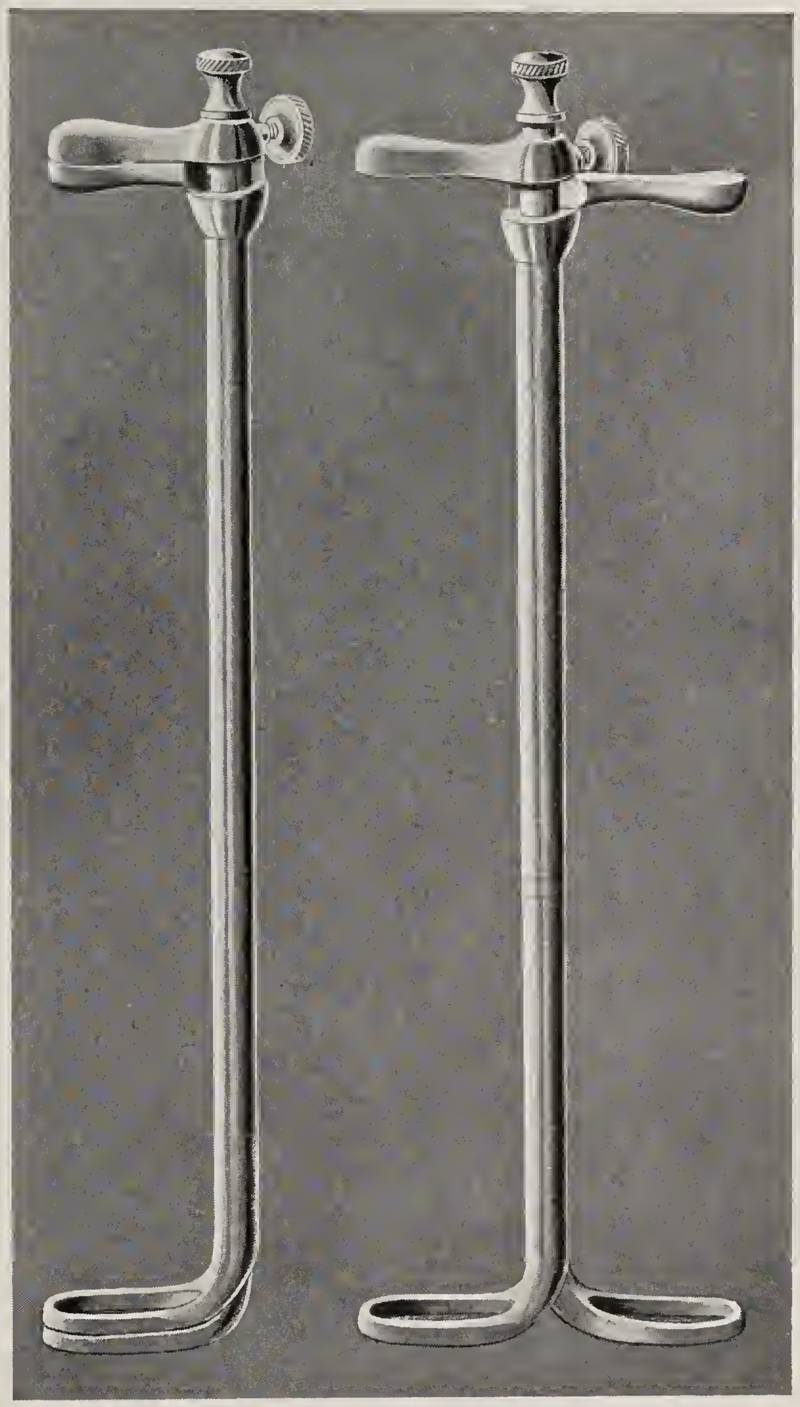
Fig. 632.—Young's Prostatic Tractor.

As a matter of fact all prostatectomies are intracapsular and more or less partial.

Incontinence of urine is present at first in cases of prostatectomy and continues for variable periods of time. Permanent incontinence is occasionally observed. **Recurrence of the obstruction** may follow an inadequate operation.

In the **after-treatment of prostatectomy** the patient should receive as much fluid as possible, including saline enemas. Urotropin in 7½-grain doses three or four times a day should be administered and the bladder irrigated once daily or oftener. The tube is removed as soon as the urine is clear and the wound granulating. The patient should be encouraged to sit up as soon as possible.

Tumors of the Prostate.—Cysts of the prostate are (1) hydatids, which are exceedingly rare; (2) cystic dilatation of prostatic vesicles; (3) retention cysts (cystic distention of occluded prostatic glands or follicular pouches). Papilloma of the prostate may be present in connection with papilloma of the bladder.

Malignant Disease of the Prostate.—This occurs either as carcinoma or sarcoma. About nine-tenths of the cases are the former. It is found as a primary disease in men above fifty, but is most frequently met with in boys under ten. When secondary, it arises by extension from the rectum or bladder or by metastasis from a distant organ. There is no special relation between hypertrophy of the prostate and the occurrence of malignant disease. The bladder wall and the prostatic urethra rapidly become involved. Glandular involvement in the retroperitoneal and mesenteric glands occurs early; later on the inguinal glands are involved. Bone metastases analogous to the condition called "general thyroid malignancy" have been observed.

This disease is rarely recognized in its early stages, particularly in patients advanced in life, the symptoms being often referred to enlarged prostate. The first symptom observed is usually obstruction of the flow of urine. After this there is severe pain, which at first occurs only during urination, but soon becomes continuous, though increased by micturition and defecation. The pain is centered in the perineum of the rectum, but radiates to the surrounding parts. It is specially severe in the loins. Bilateral sciatica as a reflex symptom is suggestive of malignant disease of the prostate. When the dense prostatic capsule becomes involved and gives way, the typic pain ceases; dysuria is still present, however. In children obstruction of urination may be the only symptom at first.

The **diagnosis** is based on the above symptoms, conjoined with irregular and hard enlargement of the prostate. The lymphatic glands in the groin may be enlarged. Bimanual examination may detect enlarged lymphatic glands within the pelvis. The disease progresses rapidly in children; in old men its progress is less rapid.

The **treatment** is almost purely palliative. When the distress is great, permanent suprapubic or perineal drainage is indicated. When the rectum is occluded, the formation of an artificial anus is required. Radical operative measures have heretofore failed, the patients who have recovered from the operation having died within a few months of recurrence.

SECTION XIX

THE SURGERY OF THE FEMALE PELVIC ORGANS

THE PERINEUM

Lacerations of the Perineum.—These usually result from the rapid passage of the child's head through the genital fissure, or during a hasty manual or instrumental delivery. They may also occur in rare cases from rape in connection with other injuries, such as lacerations of the hymen, contusions or abrasions of the vulva, and laceration of the vagina, rectum, or bladder. In puerperal cases there may be only a slight tear at the fourchet, or the laceration may involve all the perineal structures. Finally, in addition to the latter, the sphincter ani may likewise be torn (**complete laceration**). Should the sphincter escape, the laceration is said to be **incomplete.** In complete laceration the rectovaginal septum is torn for a variable distance and a common outlet is formed for the vagina and rectum. The injury of the sphincter itself may vary from a slight tear to a complete transverse separation of its ring-like structures.

Submucous rupture, with separation of the muscular and fibrous structures of the pelvis, and without injury to the mucous membrane, may occur in tedious labors. The levator ani, the office of which is to lift the rectum and vaginal outlet forward and upward, is torn and the condition known as relaxed vaginal outlet results. Rectocele, cystocele, and prolapsus follow.

Treatment.—This is always operative. The patient should be placed in what is known as the lithotomy position (Figs. 633 and 634). In superficial lacerations a V-shaped area is denuded at the site of the former fourchet (Fig. 635). This is closed by interrupted sutures, the resulting line of union resembling the letter Y. In lacerations of greater extent complete restoration of the so-called perineal body, or the point of union of the levator ani and transversus perinei muscles across which the anterior half of the sphincter ani passes, must be obtained. The operations designed to secure this result may be divided into flap-splitting operations and denudation operations. Of the first, a modification of that known as Lawson Tait's is the best. The patient is carefully prepared by rest in bed and repeated doses of sulfate of magnesium until the bowels are thoroughly evacuated, after which small doses should be given to maintain a relaxed condition for at least two days. The diet during this time should be liquid. The cathartic should be omitted the day before operation. On the morning of the operation the large bowel should be thoroughly washed out by two high enemas. With the patient in the high lithotomy position, the lower pointed blade of an angular scissors is introduced into the remains of the median raphe and a curved incision made just outside

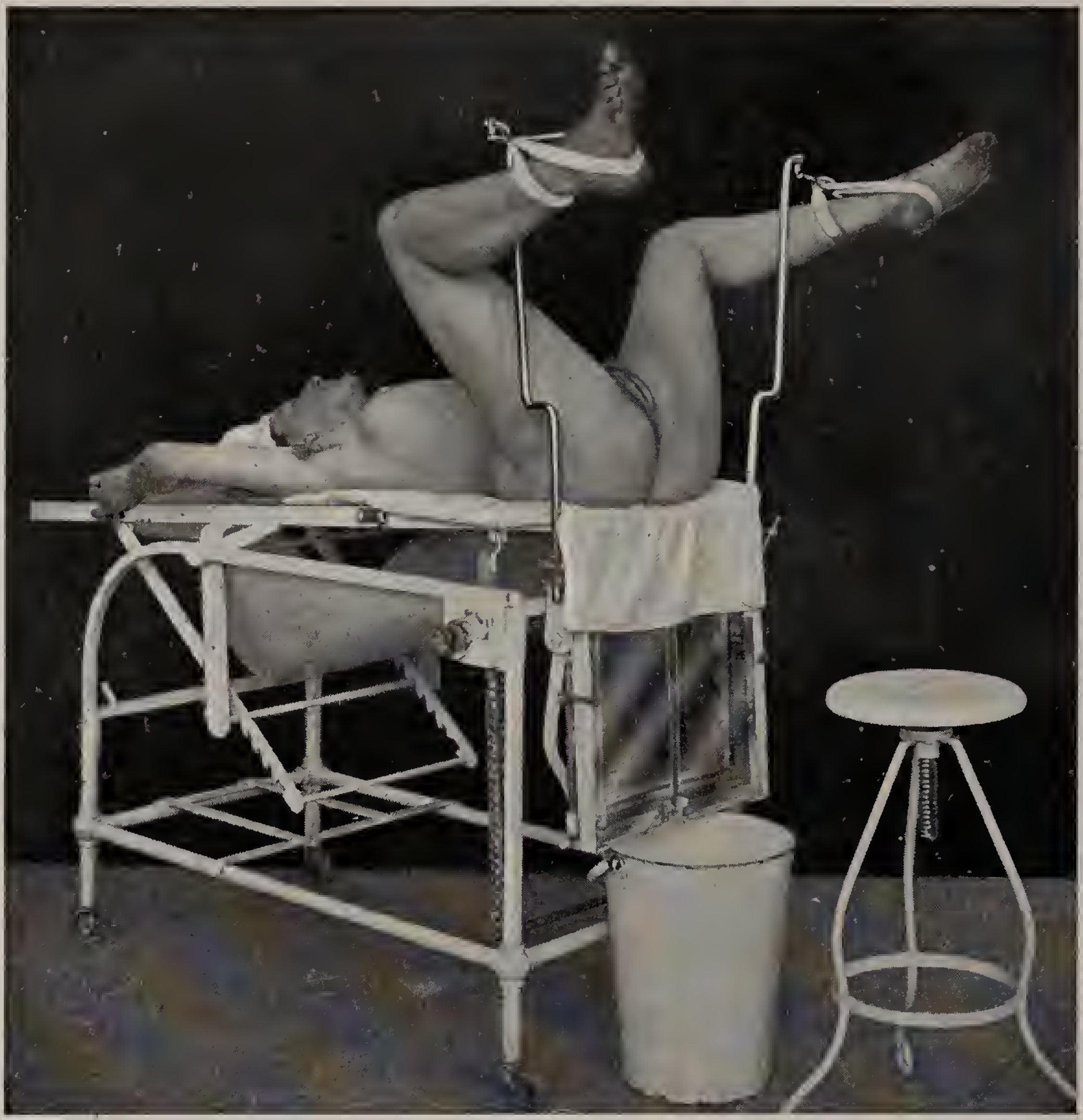

Fig. 633.—Lithotomy Position.

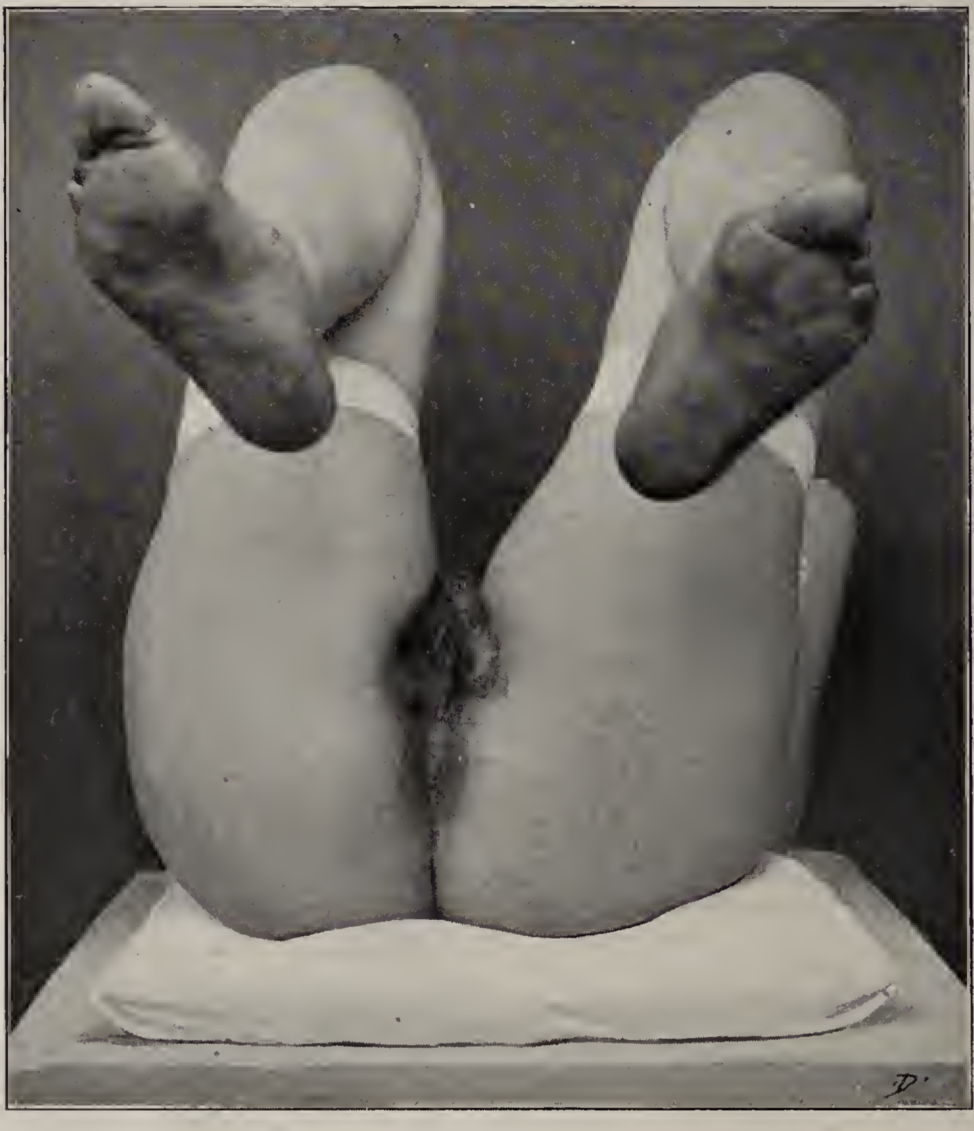

Fig. 634.—Lithotomy Position. The Limbs Held in Position by Bandages.

the junction of the skin and mucous membrane of the vagina as far as the commencement of the labium minus on each side. The posterior vaginal wall is now dissected up so as to form a flap of mucous membrane, care being taken to carry the dissection laterally on each side sufficiently to expose the retracted portions of the perineal body, and high enough to reach well beyond the upper limits of the latter. Care must be taken to avoid perforating the posterior vaginal wall or injuring the rectum. All bleeding being checked, the mucous membrane flap is held up and the edges of the gap retracted so as to expose the retracted remains of the perineal body. These are then brought into apposition and secured by buried interrupted chromicized catgut sutures. The skin edges are sutured with the chain suture (Fig. 112) of linen thread or the subcuticular suture. If there is an undue amount of redundant tissue in the mucous membrane flap, a circular or oval piece may be removed from its center. Its mucocutaneous margin should, however, be preserved.

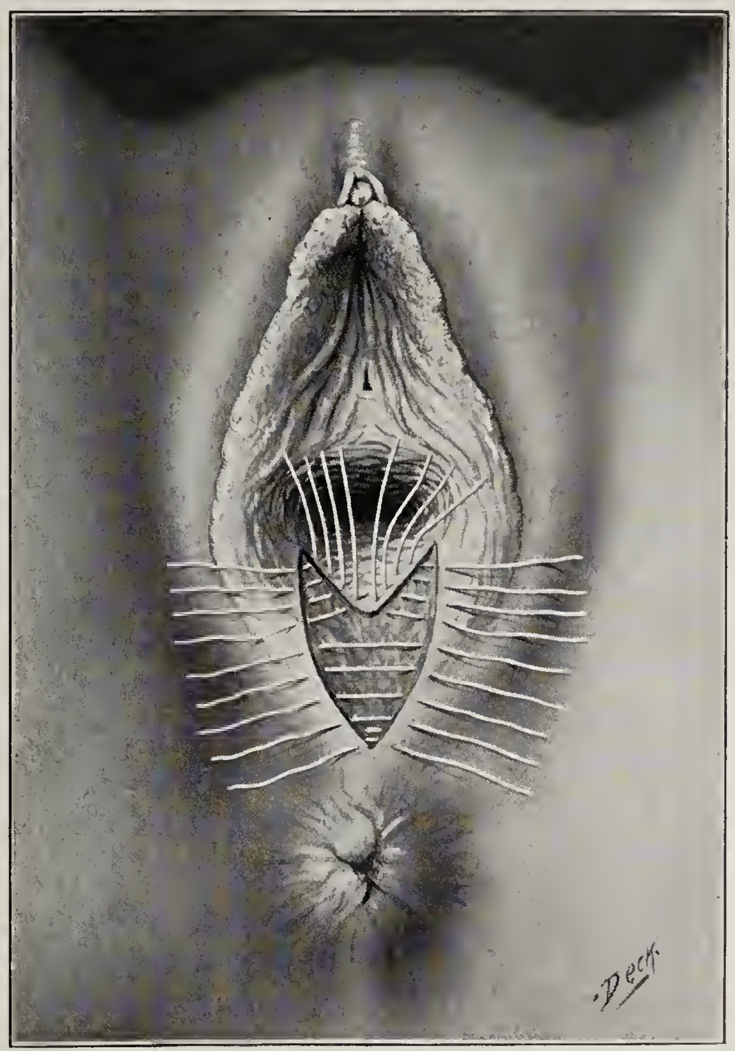

Fig. 635.—Operation for Superficial Laceration of the Perineum, showing V-shaped Denudation, with Sutures Applied Ready for Tying.

The Operation for Complete Laceration of the Perineum.—In cases of complete rupture the tear of the perineum is parallel to the raphe and sometimes in the line of it, while the cicatrix is parallel to the septum, the remains of the perineum being widely separated by the divided sphincter and buried in the torn skin and mucous membrane, along with the separated ends of the sphincter ring. The white line of the cicatrix which marks the junction of the vaginal and rectal mucous membranes, and along which the first incision is made, is brought into view and stretched by the thumbs of the operator, firmly placed outside the anal margins (Fig. 636), before being incised. This horizontal incision along the edge of the rupture is joined at each end by a short and slightly curved vertical cut, thus)————————((Fig. 637). The points where the transverse line joins the vertical lines indicate the locality where the retracted ends of the sphincter lie deeply embedded (Tait). In commencing the operation, the sharp point of the lower blade of the angular scissors enters deeply at one end of the horizontal white line (Fig. 637, 1) to the depth of a half inch and incises the latter until its other end is reached (2). The parts are steadied by placing the left index-finger in the rectum. The incision is then extended along the junction of the skin and the vaginal mucous membrane from "2" to "3". The incision from "1" to "4" is now made; then from "1" to "5" and finally from "2" to "6". The posterior vaginal wall is now dissected back to form a flap (Fig. 638). The incisions from "2" to "6" and from "1" to "5" are deepened by splitting the free edge of the tissue that borders on the rectal mucous membrane, the rectal flap being thus formed, and at the same time thoroughly uncovering the two halves of the perineal body and buried ends of the sphincter ring. The posterior vaginal flap is now lifted up out of the way by two tenacula and the free border of the rectal mucous membrane pulled downward to form the anal flap. The sutures are now applied, the method of suturing employed in incomplete rupture being used. The three posterior sutures are so applied as to produce an infolding of the rectal flap when the parts are drawn together, and the suture nearest the anal margin, the most important of all, must be buried sufficiently deep into the

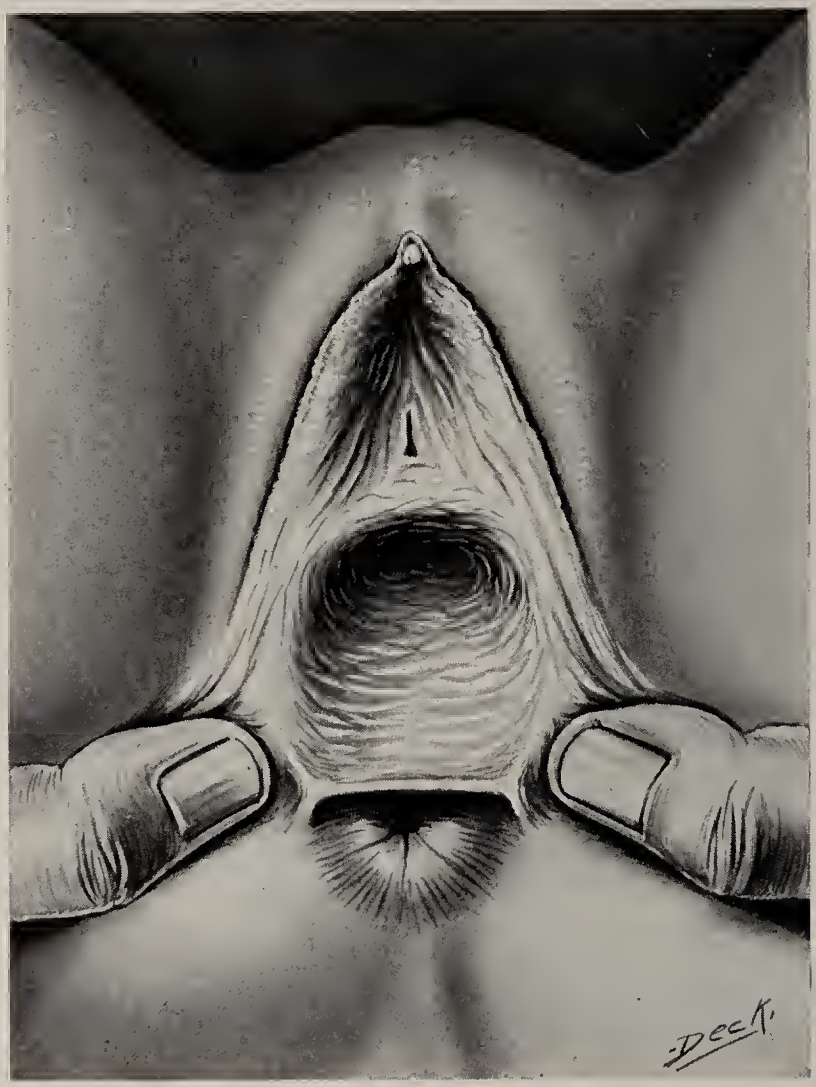

Fig. 636.—Complete Rupture of the Perineum.
Showing the method of demonstrating the white cicatricial line that marks the junction of the vaginal with the rectal mucous membrane.

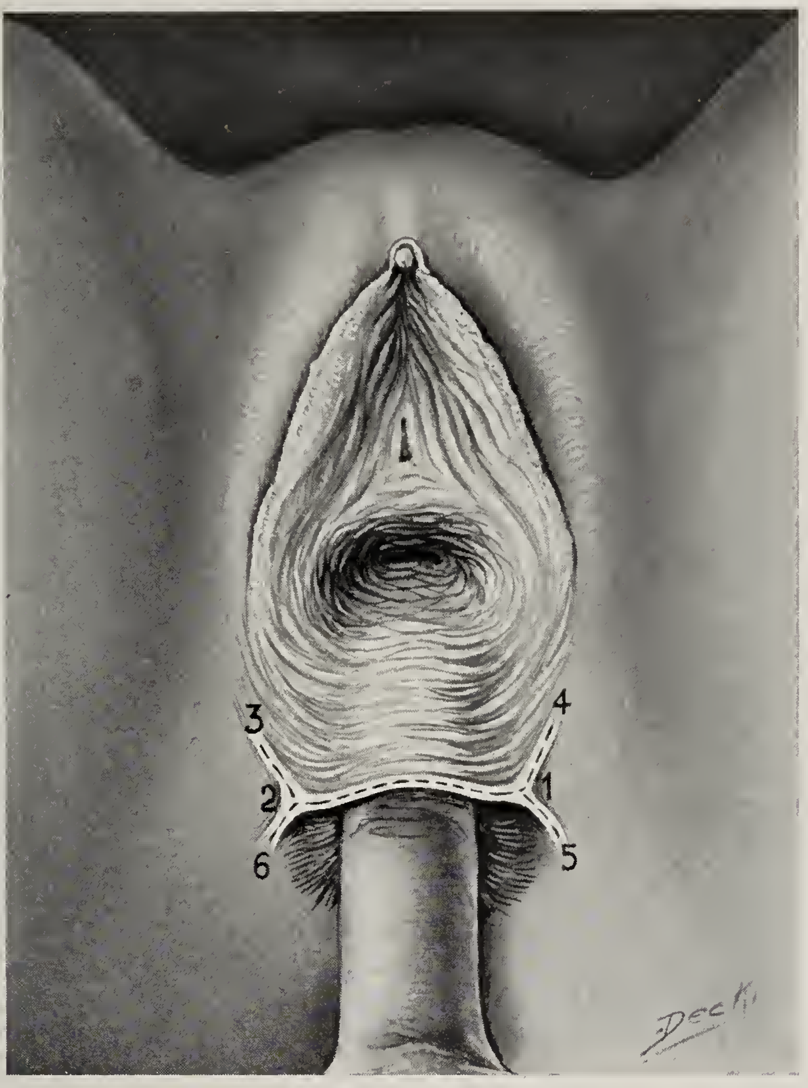

Fig. 637.—Lawson Tait's Operation for Complete Laceration of the Perineum. Showing the lines of incision for the formation of the vaginal and the anal flap.

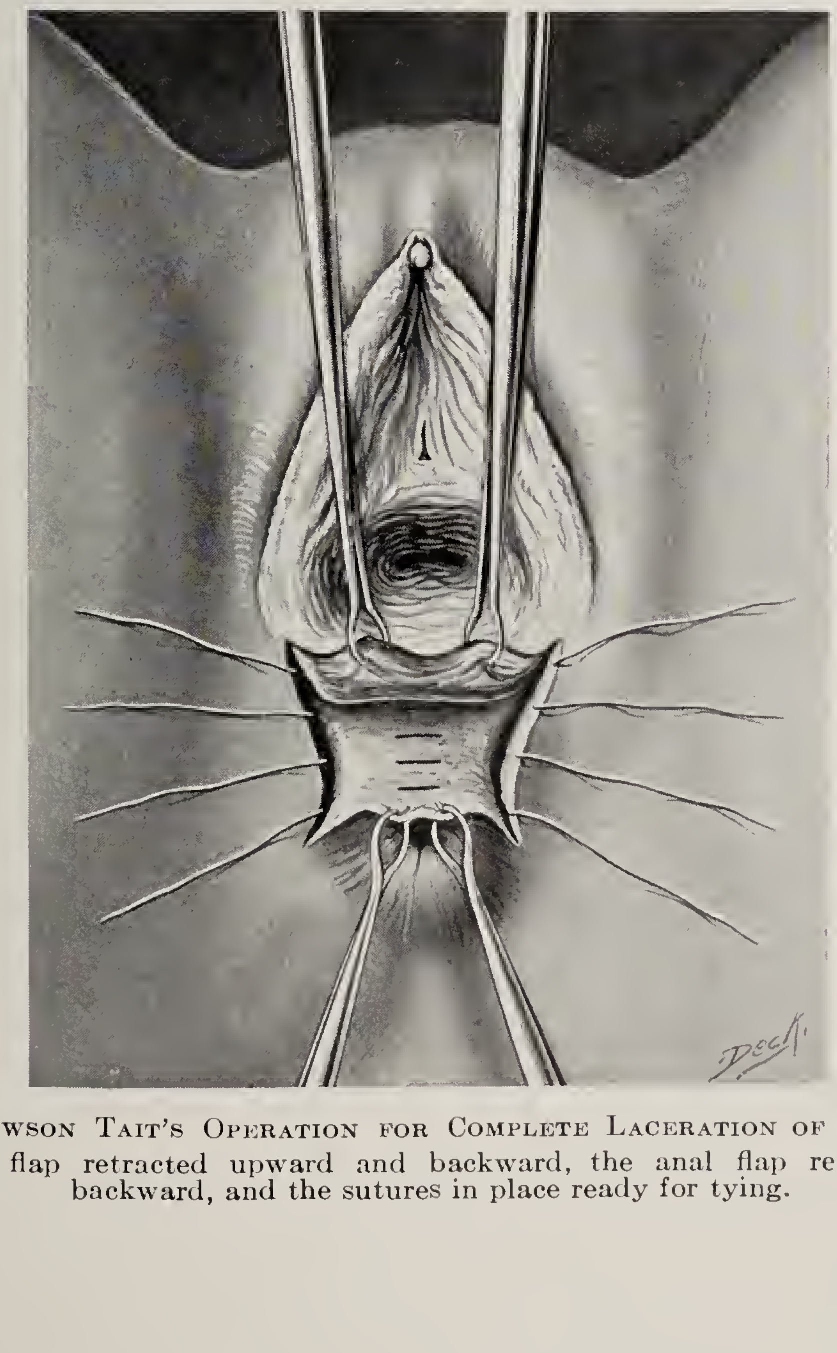

Fig. 638.—Lawson Tait's Operation for Complete Laceration of the Perineum. Showing the vaginal flap retracted upward and backward, the anal flap retracted downward and backward, and the sutures in place ready for tying.

tissues below the raw surface to secure a firm hold on the retracted stumps of the sphincter ani. Before the sutures are tied, the parts are irrigated with saline solution. Traction is now made on the anal flap by an assistant and the sutures tied so as to bring together the raw opposing surfaces (Fig. 639).

Emmet's Operation for Incomplete Laceration of the Perineum.—In making the necessary denudation, Emmet seizes the crest of the presenting rectocele or posterior vaginal wall with a tenaculum and draws this forward to a point near the urethral orifice. This is given in charge of an assistant, whose hand rests on the pubes. The lowest caruncle or vestige of the hymen on each side is also hooked up. The three tenacula are then brought together in order to demonstrate what tissues are to be united. The tenacula hooked into the caruncles are given to assistants who make lateral traction on them, whereat two triangular-shaped folds are formed by drawing out the apex of each with a tenaculum. These two surfaces are the ones to be denuded and united. The margins of the folds made prominent by the traction mark the lines for the incision, which is carried along the crest of one lateral fold to the bottom of the corresponding sutures; thence to the central tenaculum on the posterior vaginal wall; from this point it is carried to the bottom of the sulcus on the opposite side and thence along the crest of the remaining lateral fold to the margin of the vulva. Finally, the two ends of this continuous incision are united by carrying an incision from one lateral tenaculum across to the other on the opposite side. The area thus marked out is denuded. The first suture

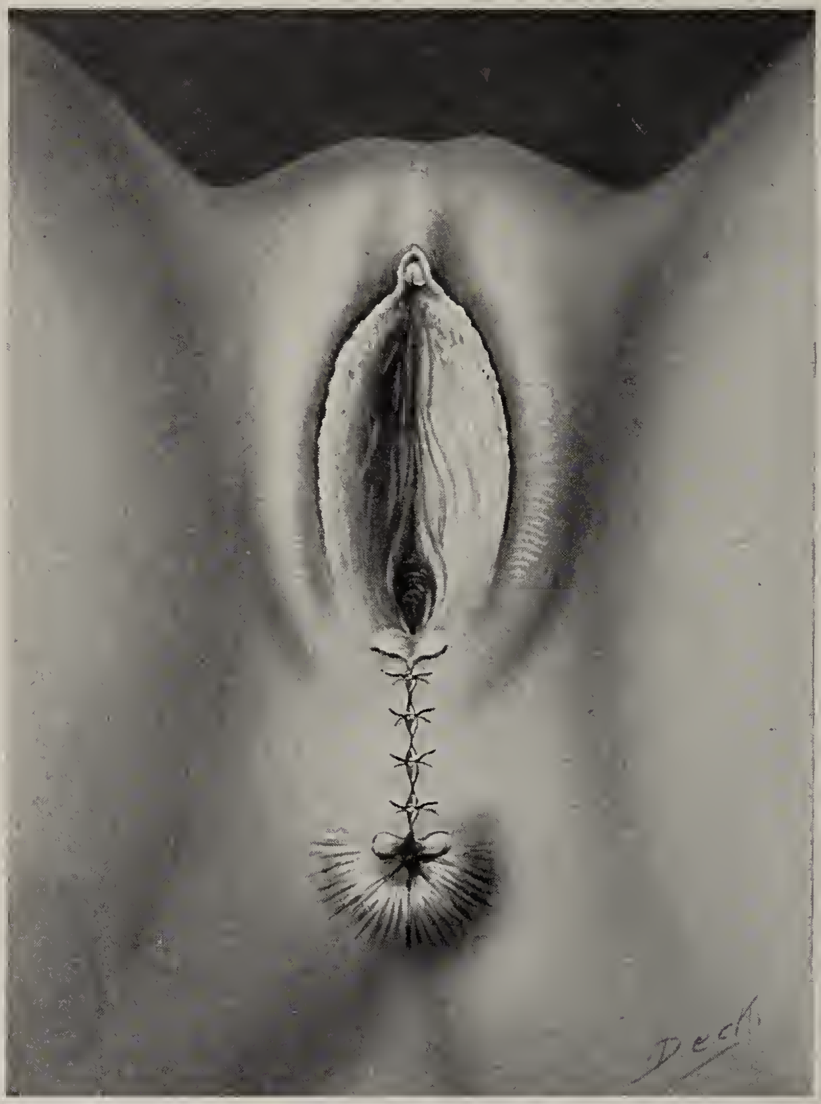

FIG. 639.—LAWSON TAIT'S OPERATION FOR COMPLETE LACERATION OF THE PERINEUM. The parts approximated and the sutures tied.

is to be introduced in the angle at the sulcus and from thence forward. The needle enters and emerges from the subcutaneous connective tissue of each margin of the denuded area, alternating from one triangular space to the other; the sutures are placed about a quarter of an inch apart. After a sufficient number of sutures have been placed in the lateral triangles to close these, the "crown suture" is passed. This enters at the site of the caruncular depression of one side, is passed deeply enough to insure a firm grasp on the levator ani muscle, emerges on the denuded surface and is again extended in the submucous tissue near the apex of the tonguelike projection of the posterior vaginal wall formed as the two lateral triangles are closed. It then passes over to the other side, taking in the structures corresponding to those on the first side (Fig. 640). Provision is now made to close the space remaining between the crown suture and the posterior limit of the denuded surface. This is done by passing a few interrupted sutures from side to side. The sutures closing the lateral triangles should be of chromicized catgut. The crown suture and extravaginal sutures may be of silkworm-gut (McMurtry).

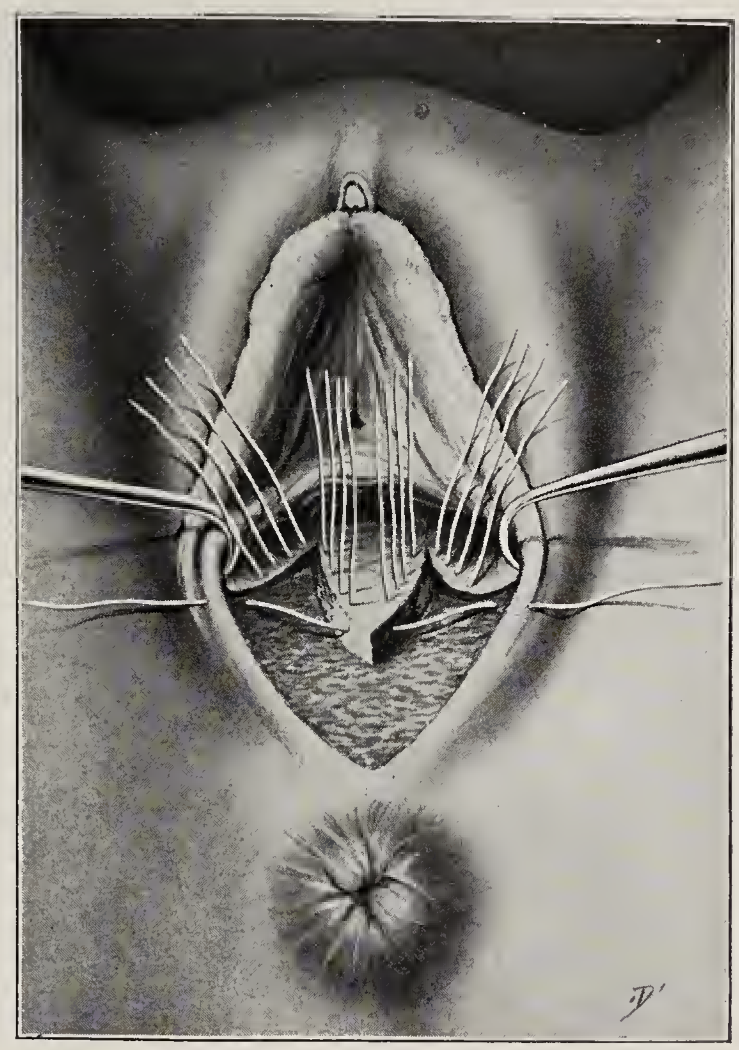

Fig. 640.—Emmet's Operation for Laceration of the Perineum.

The "crown suture" is shown crossing the base of each lateral triangle and including the submucous connective tissue, the levator ani muscle, and the apex of the posterior flap.

A rapid and efficient method of securing the effect of Emmet's procedure is to perform the modification of Lawson Tait's flap-splitting method described on page 343, and then remove a triangular-shaped part of the flap on each side. The suturing is done as in Emmet's operation.

THE VULVA

Contusions of the Vulva.—Injuries to this structure are rare. A blow, a kick, or a fall, or, if the patient is in the pregnant state, pressure of the descending head or bruising with the forceps, may result in **pudendal hematocele.** The resulting tumor may vary greatly in size. If caused by external violence, with a large or rapidly developing clot, it should be incised under an anesthetic and the bleeding point identified and ligated. Otherwise it should be treated by means of rest and the application of an ice-bag. On the first sign of septic infection it should be freely incised and treated antiseptically. In parturient cases incision of a pudendal hematocele should be delayed to the limits of safety on account of the risks of puerperal septicopyemia resulting from infection of the genital passages. Simple contusions are best treated by cleansing and shaving the parts and applying a 2 per cent solution of carbolic acid in absorbent cotton and covering with oiled silk.

Lacerated and Punctured Wounds of the Vulva.—These are quite common among female bicyclists and among servants who fall astride chairs or other articles of furniture in the course of their work. Children, as well as elderly females with inelastic soft parts, who are the victims of rape, suffer from lacerations of the vulva. Punctured wounds sometimes arise in children while at play from sliding down an inclined plane with splinters on it. Wounds of the vulva are to be treated with antiseptic cleansings and closed by sutures.

Vulvitis.—This is the result of bacterial infection. Gonorrheal infection is the most important, as well as the most frequent variety of infection. The vulva, not the vagina, as is commonly supposed, is the primary seat of gonorrhea in women. The symptoms are burning pain on urination and a copious creamy discharge. The vulvar folds present areas of erythema, which finally become distinct erosions, owing to the destruction of the epithelium. There is tenderness along the course of the urethra, which is swollen; "pouting" or eversion of its mucous membrane at the meatus urinarius is usually well marked. The presence of the gonococcus of Neisser can always be demonstrated in the discharge of true gonorrheal vulvitis. In chronic cases there is a history of an acute attack, followed by a persistent leukorrheal discharge. Cystic degeneration of the glands, or suppuration of the vulvovaginal glands may occur, followed by fistulas leading to these. Venereal warts may be present.

Treatment.—Gonorrheal vulvitis is rarely seen by the surgeon until the vagina is involved. If, however, the vulva alone is affected, every effort must be made to limit the disease by the thorough cleansing of the parts, rest, and the application of lotions of boric acid and sublimate solutions. The pudendum should be shaved and the cleansing effected with a 1 per cent solution of lysol or a warm borax solution. After this, the parts are to be washed with a 1:5000 sublimate solution. The cleansing should be repeated two or three times daily. Wet sublimate dressings of the same strength should be kept applied in the intervals. A 5 per cent nitrate of silver solution, or a 10 per cent protargol solution is applied the first day; on subsequent days the silver solution in 2 per cent, or the protargol in 5 per cent strength is applied.

The **simple vulvitis** of adults is the result of lack of cleanliness. It may occur as the result of irritating discharges. It is characterized by redness, the discharge of mucopurulent matter, swelling of the labia minora, and itching and scalding during micturition. The disease occurring in children may be communicable.

Tuberculosis of the vulva may occur as a primary disease, or as a secondary manifestation of tuberculous disease in the lung, the intestine, or the pelvic organs. In cases in which the disease is primary, infection may occur through a breach of continuity of the surface by semen containing the tubercle bacilli (Barbier), by the finger of an attendant, or by unclean instruments. It occurs alike in children and adults. The disease is essentially a lupus of the vulva. Extension takes place to the urethra and the latter may become almost entirely destroyed.

Treatment.—Thorough removal of the diseased tissues is the only measure of treatment that holds out any prospect of cure. Attempts may be subsequently made to supply the defect by a plastic operation. When radical removal is not possible, thorough curetting, followed by the application of strong nitric acid, may be tried. Unna's method of treatment consists of incising each nodule and applying on a bit of absorbent cotton twisted on a sharp stick the following: corrosive sublimate, 1 part; carbolic acid, 4 parts; alcohol, 20 parts. This is kept in contact with the parts for ten minutes.

Erysipelas of the vulva is due to streptococcus invasion of the pudendal structures through some abrasion of the surface. A chill, followed by fever and general malaise, occurs. The vulva becomes the seat of a rapidly progressive swelling, with throbbing pain. Heat, dryness, and itching are early symptoms. Edema of the vulva supervenes and small vesicles appear. The infection spreads rapidly through the lymph capillaries of the surrounding skin. Foci of suppuration may form.

The treatment consists of the application of a 5 per cent solution of carbolic acid in liquid vaselin, painted on with a camel's-hair pencil. The affected surfaces should be protected from the air.

Diphtheria of the vulva may be primary or secondary. The latter is more frequent. There is chill, fever, rapid and feeble pulse, and prostration. The structures of the vulva are tender and the characteristic exudate is found on inspection. In young subjects **noma of the vulva** may be caused by the presence of the Klebs-Löffler bacillus.

The **treatment** consists in the use of antitoxin as a constitutional remedy. When there is local destruction of tissue, hot antiseptic applications should be employed and sloughs removed as early as possible.

Chancroid.—The soft chancre, as it attacks the vulva, is essentially a venereal disease. The contagion is conveyed by means of the secretion of a chancroid or the pus of a chancroidal bubo. An abrasion or other breach of continuity of the surface is necessary for its transmission. It is autoinoculable, transmission, even to distant parts, taking place from contact of surfaces. It may spread superficially from the original point of infection (**serpiginous chancroid**); or, in addition to its superficial extension, it may be deeply destructive (**phagedenic chancroid**). The neighboring lymphatic glands quite frequently become infected (**chancroidal bubo**). Soft chancres occur primarily at the ostium vaginae and the adjacent parts, as well as about the anus, on the inner surface of the thighs and the lower portion of the abdominal wall.

The period of incubation is from twenty-four to forty-eight hours and the first manifestation is a small pimple or pustule, surrounded by an inflammatory area. This is soon replaced by a round or oval ulcer, with sharply defined punched-out appearing edges and an uneven bottom, covered, in the commencement, with dirty, grayish appearing, necrotic tissue. The discharge is abundant, thin, purulent, and sometimes has a reddish-brown color. There is more or less infiltration of the surrounding and underlying cellular tissue.

Treatment.—The parts should be thoroughly cleansed three or four times a day with hydrogen peroxid and dusted with iodoform. Where there is a tendency for the lesions to spread, the parts should be anesthetized with a 5 per cent solution of cocain and the chancroid cauterized with pure carbolic acid. Granulations may be stimulated by a 30-grain to the ounce solution of sulfate of copper. Indolent chancroids should be thoroughly curetted. Pain is best relieved by the carbolic and opium lotion (2 per cent solution of carbolic acid, 1 pint; tincture of opium, 1 ounce), applied warm on gauze compresses. Olive-colored urine must be watched for, the carbolic solution being discontinued at once on its appearance and a weak solution of corrosive sublimate substituted.

An uncomplicated chancroid will heal in about three weeks under cleanly and antiseptic conditions. The inoculable characteristics of the sore persist until healing is complete.

Hard chancre may be frequently overlooked in women, owing to its small size in many instances, its transient characteristics, and the conformation of the parts on which it occurs. It may be further obscured by associated inflammatory conditions. As a rule, the induration of the chancre, as it occurs in women, is less than in men. Hard chancre appears in women as (1) a superficial erosion; (2) the scaling papule or tubercle; (3) the elevated papule; (4) the incrusted chancre; (5) the indurated nodule; (6) the diffuse ulcerated chancre.

Chancres of the genital organs in women are usually painless, with the exception of those on the clitoris and fourchet. Burning and itching sensations are sometimes complained of.

Chancres, as they occur on the different parts in this region, offer the following special characteristics (Taylor):

On the labia majora all the varieties occur. The scaling papule or tubercle and the incrusted chancre occur on the outer or skin surface. In addition to these, the chancrous erosion, the ulcus elevatus, the diffuse ulcerated chancre, and the indurated nodule are found on this structure. Indurated edema is frequently present.

On the labia minora the three most important varieties observed are the chancrous erosion, the ulcus elevatus, and the diffuse ulcerated chancre. Chancres on this structure are all more or less indurated.

On the preputial covering of the clitoris the chancrous erosion and the incrusted chancre are found. Induration is usually marked.

On the fourchet the chancre is of the erosive, incrusted, or diffusely indurated type.

Chancres of the vaginal introitus, the urinary meatus, and the myrtiform caruncles present no special characteristics. They usually occur as irregular areas of induration, with ill-defined margins. These are generally very difficult to diagnose without considerable delay and careful study.

The **treatment** of chancre in women, in addition to the general measures of treatment used for men, includes special measures to insure local cleanliness. Frequent irrigations of hot water, to which borax may be added, and a wash of corrosive sublimate used twice daily, 1:2000, are serviceable. Small pledgets of absorbent cotton wet with the same solution may be kept applied to the vulva. Some recommend keeping the parts dusted with calomel where a slightly stimulating and protective application is alone indicated. The red wash (sulfate of zinc, 8 grains; compound spirits of lavender, 2 drams; water sufficient to make 4 ounces) may be used.

Elephantiasis of the vulva springs from the labia majora, labia minora, or clitoris. When springing from the labia majora, the mass may reach the knee. Histologically it represents a hypertrophy of connective-tissue elements. It may appear as an inflammatory process or as an acquired lymphostasis. The surface is generally smooth; at times it is covered with small nodules or warty growths. A congenital form is sometimes observed; this is a true cavernous cystic lymphangioma of the labia majora.

The **treatment** consists in extirpation of the redundant masses and suture with fine catgut.

Atrophy of the Vulva (Kraurosis Vulvae).—Atrophy of the skin and subcutaneous tissue of the labia majora, the fourchet, and sometimes the perineum, commences as small, reddish, painful and tender areas around the ostium vaginae, which later becomes narrowed, with diminished elasticity of the tissues. The atrophy is progressive, the labia minora and labia majora almost completely disappearing; atrophy of the mons veneris and complete alopecia sometimes occur.

The **palliative treatment** consists in the use of carbolic and other lotions to relieve pain. Cocain should be avoided wherever possible. The **radical treatment** consists in complete extirpation of the affected parts.

Intertrigo of the vulva is found in fleshy women, and is caused by friction of the skin surfaces, conjoined with abundant perspiration. Itching and burning sensations accompany the affection. It is also caused by gonorrhea, syphilis, and irritating discharges from the vagina. The **treatment** consists in cleanliness and the dusting of the parts with equal portions by weight of boric acid and oxid of zinc, or the use of the officinal ointment of oxid of zinc.

Erythema of the vulva is usually due to glucosuria. It is frequently accompanied by pruritus. The parts should be washed with green soap and water, irrigated with a 2 per cent solution of carbolic acid, after which carron oil, to which is added 4 per cent of ichthyol, is to be applied.

Eczema of the vulva, both acute and chronic, affects the labia majora and minora, the clitoris, and extends to the vaginal mucous membrane, to the upper portion of the thighs, and to the perineum and anus. There may be a profuse secretion from the skin, or it may be simply dry, rough, and perhaps scaly. The itching is unbearable. The **treatment** consists in the cleansing of the parts with borax solution and vaginal tampons soaked in a 25 per cent mixture of ichthyol in glycerin; these are left in twelve hours. The itching is relieved by temporarily applying a 2 per cent solution of carbolic acid in equal parts of alcohol and rose-water. Afterward a lotion consisting of a 10 per cent mixture of ichthyol in an emulsion of oil of sweet almonds and lime-water, two drams of each, to which is added glycerin and rose-water, one ounce of each, is very useful (Ravogli). As the skin surface approaches the normal, the carbolized oxid of zinc ointment may be applied.

Folliculitis of the vulva occurs as a subacute or a chronic affection of the hair-follicles and sebaceous glands of this region, due to the presence of the **Staphylococcus pyogenes albus,** the **Staphylococcus pyogenes aureus,** and the **Staphylococcus pyogenes citreus.** The swollen and inflamed hair-follicle is converted into a small abscess. It may be associated with diabetes or ammoniac urine; a crop of boils is sometimes present in the neighborhood. The **treatment** consists in strict cleanliness, the application of wet bichlorid compresses, followed by ointments containing carbolic acid and subnitrate of bismuth or salicylic acid and oxid of zinc.

Herpes Progenitalis.—This is analogous to herpes praeputialis. An eruption of vesicles appears on the mucous membrane surfaces of the vulvar orifice. It occasionally appears on the skin surfaces. Slight burning and itching precede the appearance of the vesicles. Unless seen before the vesicles are broken the resulting ulceration may be mistaken for a venereal infection, particularly for the erosive hard chancre. The punched-out, round and ragged, and rapidly spreading ulcer of chancroid will prevent the mistaking of herpes progenitalis for that disease. The **treatment** consists in douching with warm borax water, the use of lead and opium wash, and the application of powders, such as oxid of zinc or subnitrate of bismuth, when the parts are healing. If the disease is obstinate, the parts may be touched with a 5 or 10 per cent solution of nitrate of silver.

Aphtha or **thrush,** as it attacks the vulva and vagina, does not differ materially from the affection as it appears in the infant's mouth. It is due to the presence of the **oidium albicans.** There is some local pain. White patches of exudate are present on an inflammatory base. The disease yields readily to daily cleansing with sterile water, followed by the application of a 1:500 solution of corrosive sublimate and the use of boroglycerin tampons.

Pruritus vulvae is an affection in which the itching is the only symptom. This is so intense and persistent that the patient rubs and scratches the genitals until excoriations are produced. Certain inflammatory lesions follow and the skin of the genitals becomes swollen and edematous. The woman becomes hysteric and even nymphomaniac. A vaginal discharge supervenes from extension of inflammation to the vagina, which aggravates the original trouble. It occurs most frequently during the menopause and usually in connection with a general neurotic condition.

The **treatment** consists in the application to the genitals of cold evaporating lotions in the shape of compresses, containing alcohol and either carbolic or salicylic acid in the proportion of about 2 per cent. Vaginal douches of borax, followed by compresses wet with a solution of tannin in the proportion of a half ounce to the quart, or tampons of 25 or 50 per cent ichthyol in glycerin, are useful. Galvanism has been recommended. Careful attention should be paid to a hygienic régime. In extreme cases, when all other measures fail, operative treatment may be resorted to. This consists of the removal of the affected area. The clitoris and its prepuce, the labia minora, and sometimes a portion of the labia majora, may require excision.

Papillary growths occur as the result of irritation, such as gonorrhea, and appear in the shape of pointed condylomas (**venereal warts**). They are found on the labia majora and labia minora, and extend to the adjacent skin surfaces. They occur as solitary excrescences, united in smaller groups, or as enormous confluent masses covering the whole of the pudendum, the cauliflower appearance of which may cause them to be confounded with carcinoma (see Condylomas, page 356).

Urethral Caruncle.—This is a small mucous polypus frequently found at or near the urethral orifice. It is usually about the size of a pea, but may attain the size of a hazelnut. It is soft in consistency, of a bright red color, and its surface is either smooth or raspberrylike. It may be pediculated or sessile.

It is exquisitely sensitive, giving rise to painful urination; marital relations are often impossible. In a case under my care at the German Hospital in Brooklyn what at first appeared to be a urethral caruncle proved to be a true angioma, an exceedingly rare neoplasm occurring in this locality.

The **treatment** consists in removal, which may be usually accomplished under local anesthesia. Care should be taken to remove all of the base, else the condition may recur.

Fibromas of the vulva spring from the connective tissue beneath the surfaces of the labia majora and labia minora. Sometimes the tumor assumes the characteristics of a myxoma or fibromyxoma. It grows slowly, but in time may attain a large size, becoming pediculated and in some instances reaching to the knees. Ulceration and calcareous degeneration may occur.

Polypi spring from the connective tissue of the labia majora or labia minora, and exceptionally from the clitoris. Those of the myxomatous type may occasionally be found.

Lipomas develop from the fat tissue of the labia majora, or mons veneris, where they form roundish masses. Lipomas of the vulva are very rare.

The **treatment** of these growths is by extirpation. There is no tendency to recurrence.

Carcinoma of the Vulva.—This appears as a nodular growth, a papillary tumor, a diffuse infiltration, or a deeply excavated ulcer. It is found most frequently springing from either the skin or the mucous surfaces of the labia majora, occasionally from the labia minora, and very rarely from the clitoris. It is most frequently observed between the ages of forty and fifty. The disease is often preceded by syphilitic leukoplakia. The inguinal glands become infected. Metastasis is extremely rare. **Carcinoma of the vulvovaginal gland** appears as a hard tumor beneath the labium majus. Rapid spread of the disease takes place, the entire pudendum and surrounding parts becoming finally involved if the patient survives. Recurrence is the rule even after thorough removal.

Sarcoma of the vulva is a rare disease. The round-celled and the spindle-celled varieties have both been observed. Melanosarcomas occur somewhat more frequently; they usually spring from pigmented spots and pigmented nevi on the vulva. Developing under these circumstances, the growths are of a most malignant type. Myxosarcomas have also been described. The vulva is not infrequently the seat of sarcomatous metastasis arising from sarcoma elsewhere in the body.

The **treatment** is early excision. The prognosis is exceedingly unfavorable.

Varices of the vulva occur as a part of general disturbances of the circulation. They are found most frequently in connection with pregnancy; the veins of the labia majora particularly become greatly congested and dilated. Ovarian and uterine tumors may also produce them. Inflammatory (**phlebitis**) and degenerative (fatty or calcareous) changes may occur. Hemorrhage into the tissues from rupture may give rise to **hematoma of the vulva.**

The **treatment** consists in obliteration of the veins by ligation. When the varices are associated with marked hypertrophy of the parts, the hypertrophied area should be excised.

Hydrocele of the Round Ligament.—This develops precisely as does hydrocele of the cord in the male. The serous accumulation is limited, as a rule, to the canal of Nuck; the sac may protrude beyond the inguinal ring and simulate a hernia. The **treatment** consists in opening up the inguinal canal to the extent of the hydrocele, isolating the sac, ligating the latter at its pedicle, and extirpating it. The canal is then sutured as in the operation for the radical cure of hernia.

Condylomas.—These develop on an inflammatory basis. In the great majority of cases the inflammation originates in either gonorrhea or syphilis, hence they are commonly called "venereal warts." Less frequently they are nonspecific. They occur on all parts of the external genitals of females, and not infrequently appear on the perineum, about the anus, and over the inner surfaces of the thighs. They consist of hypertrophies of the papillary layer of the skin. They occur at first isolated in small groups; these latter may become confluent. When occurring in cauliflower-like masses, they may be mistaken for carcinomas of the vulva. Small excrescences may appear on the pudendum due to frequent masturbation. They are situated between the hymen and the labia minora and about the external meatus.

The **treatment** of condylomas consists in curetting them thoroughly away. If the bleeding is excessive, as it is likely to be, it may be arrested by means of a compress wet with a saturated solution of perchlorid of iron. In case of recurrence they should be touched with chloracetic acid.

Cysts of the Vulva.—These are usually retention cysts, the majority of which develop from the glands of Bartholin or their ducts. Cysts of Gärtner's duct may occur in the vulva. Atheromatous cysts and dermoids are sometimes found in the labia majora. Small multiple cysts of the hymen are occasionally observed.

Cysts of the vulva, except those of the glands of Bartholin, which are usually of gonorrheal origin, as a rule give rise to no inconvenience and are generally discovered only by accident. The **treatment** is by excision.

THE VAGINA

Injuries of the Vagina.—**Punctured wounds of the vagina** may occur from sitting or falling on some sharp object. The peritoneal cavity may be invaded or the bladder or rectum may be opened. Injury of an abdominal viscus will necessitate an immediate abdominal section. In the case of the bladder or rectum a vesicovaginal fistula will result.

Ruptures of the vagina are due to parturition. They occur most commonly in the posterior wall, though they may involve the fornices and broad ligaments, giving rise to dangerous hemorrhage. The **treatment** is immediate, with thorough cleansing, trimming off of the contused margins, and suturing with fine silk, the ends being left long for subsequent removal.

Fistulas communicating with the vagina are usually the result of parturient injuries. They may communicate either with the urethra (**urethrovaginal fistula**), with the bladder directly (**vesicovaginal fistula**), with the bladder through the uterus (**vesico-uterine fistula**), with the ureter directly (**ureterovaginal fistula**), or with the ureter through the uterus (**uretero-uterine fistula**). In addition to these, a communication may be established between the vagina and the rectum (**rectovaginal fistula**).

Urinary fistulas which open directly on the mucous membrane of the vagina vary considerably in size. Urethrovaginal and vesicovaginal fistulas when of sufficient size may be readily recognized by the prolapse of the bright red mucous membrane of the bladder. When small, they may be detected by the probe or by means of a colored solution injected into the bladder. In old cases the bladder contracts and its walls become thickened; atresia of the upper part of the urethra sometimes exists. Vesico-uterine fistulas are rare. When suspected, their presence may be demonstrated by the colored solution test. Ureterovaginal fistulas are usually the result of injury to the ureters in the operation of panhysterectomy.

Treatment.—A certain proportion of the cases of urethrovaginal and vesicovaginal fistulas close spontaneously under vaginal and bladder irrigation with a borax solution. Operation should be deferred for at least two months, in order to give the tissues time to contract. In conducting the operative procedure, the parts must be brought well into view by either the Sims position (Fig. 641) or the knee-chest position (Fig. 642). The edges of the fistula are to be carefully pared. In Sims' operation the mucous membrane is avoided. In other operations the entire thickness of the edges is pared. The flap-splitting method is employed by some. Any of these methods will give good results, provided the denudation is thoroughly done, the raw edges exactly approximated by sutures which make their exit and entrance well beyond the edges and do not include the mucous membrane of the bladder, and proper precautions are taken to prevent contamination of the wound by urine. In paring the edges, each side of the fistulous opening is to be grasped by a tenaculum. A sound passed into the bladder may be used to render the bladder wall more prominent. Either silver wire or aseptic silk may be used for suture material. The former may be easily passed with the aid of a double loop of silk. Iodoform or other sterile gauze should be packed into the vagina after the sutures are secured and the ends cut off, and a sigmoid or other form of self-retaining catheter, with several feet of drainage-tubing attached, should be introduced into the bladder. In the after-treatment the patient is to be

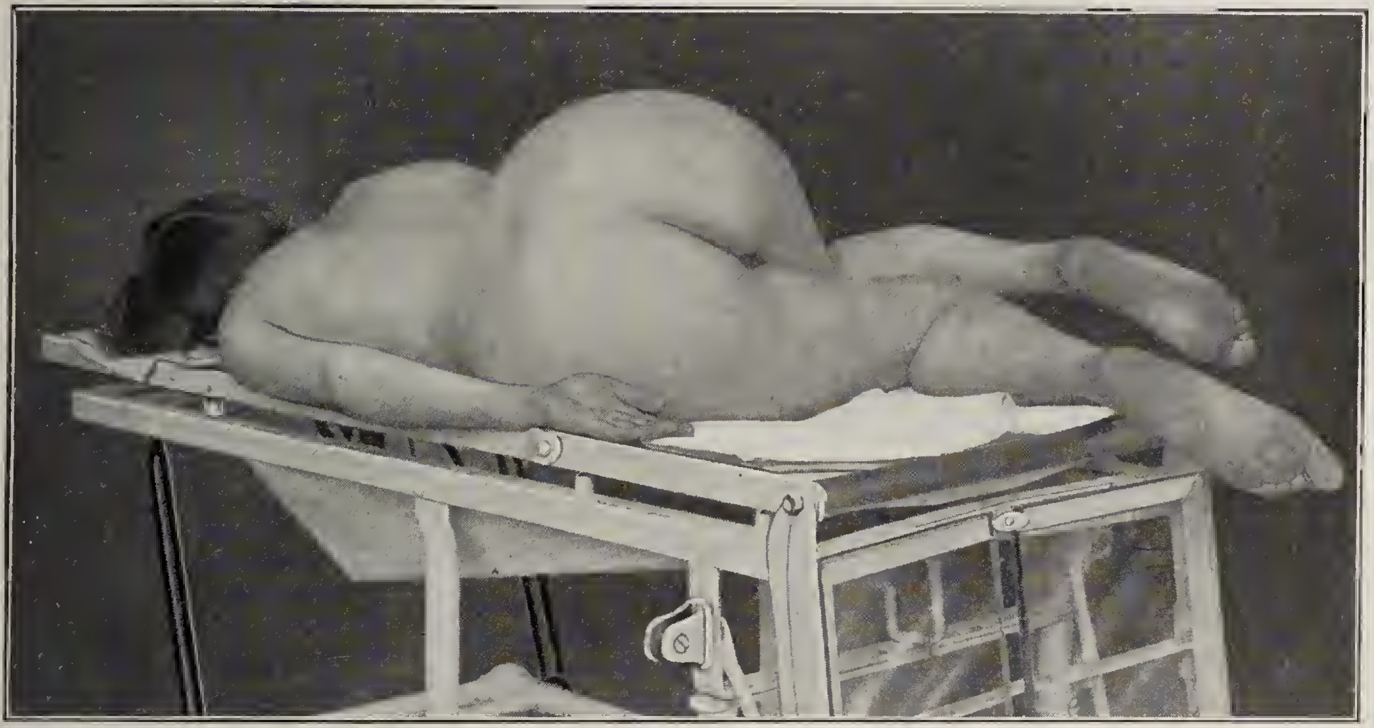

Fig. 641.—Sims's Position.

kept in the semiprone position (Marion Sims). The catheter must be removed and cleansed every day. The sutures are removed on the tenth day.

Vesico-uterine fistula may be dealt with by separating the uterus from the bladder, as in vaginal hysterectomy, and closing the fistula by a double layer of chromicized catgut sutures (Reed). In case it is found impossible to bring the bladder within reach by the vaginal route the abdominal route should be employed. In either case the uterus should be curetted and drained. Closure of a ureterovaginal fistula is very difficult and that of a uretero-uterine fistula impossible except through an abdominal incision. The most certain method of dealing with these fistulas is to implant the ureter into the bladder through an abdominal section.

Rectovaginal Fistula.—This distressing condition may result from parturient injuries, carcinoma, or syphilis. It may also arise from the pressure of a pessary or other foreign body and from punctured wounds. In these latter cases the fistulas may be healed by antiseptic douches and gauze packing in the vagina, aided by temporarily paralyzing the sphincter ani through stretching.

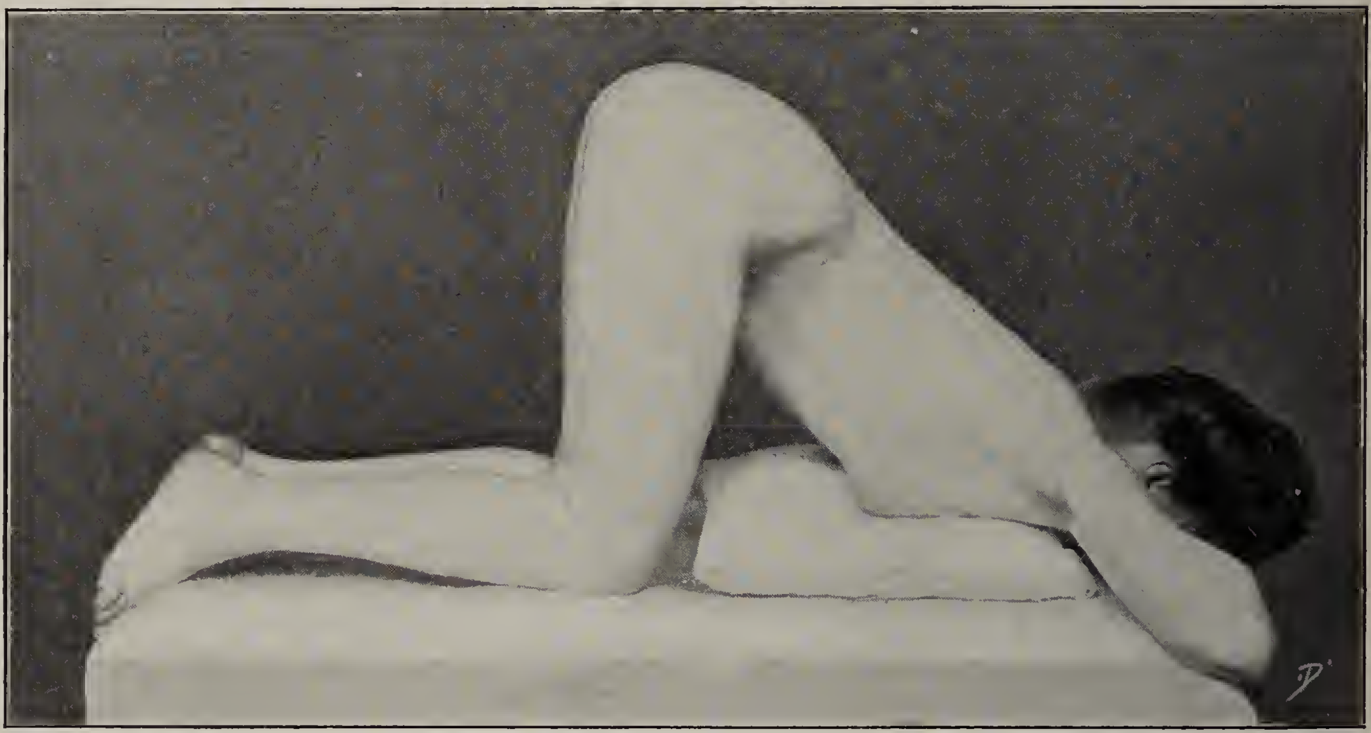

FIG. 642.—THE KNEE-CHEST POSITION.

Treatment.—The operation should be preceded for three or four days by the use of aperients, and douching the vagina with borosalicylic solution. The operation is conducted with the patient in the lithotomy position (Fig. 633) and the perineum is retracted. The edges are pared and the rectovaginal septum split for about three-eighths of an inch. The sutures are of chromicized catgut and are applied in two layers. The first approximates the rectal portion of the fistula but does not include the rectal mucous membrane. The second layer closes the vaginal portion. If the fistula is low down, the tissues are cut through, including the remains of the perineum, and the gap, including the fistula, closed by the flap-splitting method of Tait, as in complete rupture of the perineum (see page 345).

In the after-treatment the bowels are confined for a week, when an olive-oil enema is given. A boric acid douche is given morning and night. The healing is complete at the end of a fortnight.

Vaginitis.—The external genital organs of women may become the seats of coincident infections by various microorganisms. That this does not occur more frequently is due to the acid secretions of the vagina, which either destroy the vitality of the pathogenic organisms or neutralize their virulence. This is believed to be due to the presence of an acid-forming bacillus found at the introitus (Döderlein). To this circumstance is attributed the fact that many of the pus microorganisms found in and about the female external genital organs fail of positive results in inoculation experiments. Nevertheless, certain microorganisms, notably the gonococcus of Neisser, are not destroyed or inhibited by Döderlein's bacillus; hence acute vaginitis from this variety of infection is comparatively common.

Gonorrheal Vaginitis.—This occurs as a result of gonorrheal vulvitis. The infection may be carried from the vulva into the vaginal canal, either through the use of a douche nozzle or some such mechanic means, or by sexual intercourse. Once the vagina is infected, extension may take place to the entire genital tract, the uterus, the Fallopian tubes, and finally the pelvic peritoneum becoming involved. Even the bladder and kidneys do not escape in some instances, the infection extending from the urethra, which becomes involved with the vulva.

The **symptoms** in the acute form are bulging of the ostium vaginae and a bright red or dusky hue of the mucous membrane of the vaginal canal. The latter is bathed with pus, which flows over the vulva, and is hot and sometimes throbbing; it is usually very tender to the touch. The cervix, as seen through the speculum, is commonly swollen and the os is often occluded with a thick plug of mucus. These symptoms, combined with those of the coexisting vulvitis, and the presence of the gonococcus of Neisser are sufficient to establish the diagnosis.

The symptoms of **chronic gonorrhea in women** are more obscure. The points to be taken into account are the following: (1) the history of a preceding acute attack; (2) the persistence of a discharge, which may vary in amount from a simple moisture to a quantity sufficient to require a napkin, and in color from a whitish to a yellowish tint; (3) a highly congested area about the orifices of the ducts of the vulvovaginal glands, or evidences of an old suppuration of these glands; (4) the presence of dark red spots and venereal warts; (5) Sänger's test, namely, increased prominence of the granules of the vaginal mucous membrane on the application of a 50 per cent solution of zinc chlorid (Bodenstein).

Treatment.—This is essentially germicidal. The vaginal canal is first thoroughly cleansed by means of a douche of borax solution, after which a douche of 1 : 2000 solution of sublimate is given. The douche is kept up for ten or fifteen minutes, the ostium vaginae being occluded at intervals by the hand, in order to effect distention of the vagina and bring the douche in contact with every portion of the surface. In obstinate cases the vaginal mucous membrane may be painted, after thorough cleansing, with a 20-grain to the ounce solution of nitrate of silver. The speculum is used to effect this application. Three or four days should elapse between the applications. In chronic cases the bactericidal measures should be persisted in; on alternate days a tampon of sterilized glycerin may be used to flush the vaginal folds with their own secretion, thus bringing the microorganisms within reach of the sublimate solution. The vulvovaginal glands should be extirpated in recurring and obstinate cases, in order to remove a very probable source of latent infection. The nitrate of silver application, made every third or fourth day through a speculum which thoroughly distends the vagina, is often of service.

Cysts of the Vagina.—Cysts in the vaginal wall arise in the remains of a persistent Wolffian or Müllerian duct (Gärtner's duct). The latter is found on either one side or the other of the anterior vaginal wall. Cysts have also developed from infolding of the epithelium after operations; they may arise from dilated lymph-spaces.

Myomas and **fibromas** are also found in the anterior vaginal wall. They are round in shape, sometimes pediculated, and either hard or soft, according to whether or not they have undergone lymphangiectatic changes. The **treatment** is extirpation.

Sarcomas in childhood appear as polypoid nodules or racemose tumors of slow growth. After remaining quiescent for years, they may take on rapid growth and quickly invade the surrounding and underlying parts. In more than half of the cases the tumor springs from the anterior vaginal wall. Histologically the growth may be either spindle-celled or round-celled sarcoma; striated muscle cells are also present in some cases. Metastases are rare. In adults the disease usually occurs in the lower third of the vaginal walls, either as a round or ovoid and well-defined growth with a smooth surface, or as a diffuse infiltration. The disease spreads from its first appearance and metastases are common. The histologic type is either spindle-celled, round-celled, or giant-celled. Myxomatous degenerative changes may occur. Finally, secondary deposits of deciduoma may occur in the vagina.

Carcinoma.—This may be primary or secondary. Primary carcinoma occurs as a rapidly growing circumscribed thickening with a tendency to ulceration, or as a papillary growth. It may occur at the vulvovaginal junction, near the urethral orifice, or in the posterior vaginal wall. Any portion of the mucous membrane may be involved, however. Secondary carcinoma occurs as an extension from the cervix uteri or rectum, from contact infection (auto-inoculation), or as a metastasis from the uterus or ovaries. The progress of the disease is rapid and the destruction usually more or less extensive. The lymphatic glands in the groin, which become early infected, are greatly enlarged, as a rule, before the patients apply to the surgeon for relief. These cases are of very unfortunate character, since surgery can do but little for them, even in the early stages, without bringing misery in the wake of the operative effort through the establishment of rectovaginal or vesicovaginal fistulas. These conditions, however, are brought about by the disease itself in its later stages.

Papillary adenocarcinoma may be found in the vagina as a metastatic growth from the ovary (Beyea). Endothelioma of the lymph-vessels or of the capillary blood-vessels has been observed.

THE UTERUS

Lacerations of the Cervix.—These usually occur as accidents of childbirth; rarely they may follow forcible operative dilatation. They may be slight and superficial or deep and extensive. More than one may occur at the same time (multiple or stellate laceration). Disturbances of local nutrition follow the accident; in parturient cases subinvolution follows. When occurring in the course of a dilatation, the tear may involve the circular or even the uterine artery. In the cases in which healing takes place spontaneously, contraction of the cicatricial tissue occurs and the cervical tissues are distorted. In the case of a bilateral laceration, this causes an eversion of the mucous membrane of the cervix; the appearance thus presented may be mistaken for ulceration. Atrophy results from superficial tears, while deep lacerations are followed by cervical hyperplasia. Associated changes in the endometrium are usually present. The pelvic lymphatic glands and even the Fallopian tubes, as well as the ovaries, may become infected and suppuration may occur in these. Carcinoma may have its origin in the cicatricial tissue after healing of a laceration of the cervix uteri.

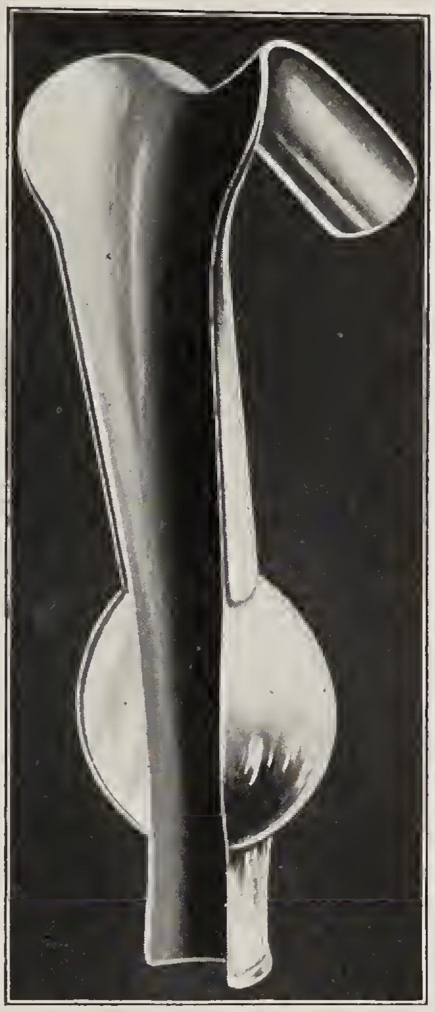

Fig. 643.—Perineal Retractor.

Treatment.—This consists essentially of a restoration of the cervix as far as possible to its normal state. The extent of the operation will vary according to the conditions present, from a simple revivifying of the edges of the tear in cases in which no tissue changes are present, to a removal of a considerable portion of the hypertrophied cervix. In the operation of **trachelorrhaphy** the patient is placed in the lithotomy position (Fig. 633). The perineum is retracted by means of a weighted perineal retractor (Fig. 643) and the cervix seized by a volsella (Fig. 644) and drawn down. The intrauterine probe (Fig. 645) is introduced and the uterine cavity and cervical canal accurately measured. The cervical canal is dilated and the endometrium curetted. The cicatricial tissue in the angles

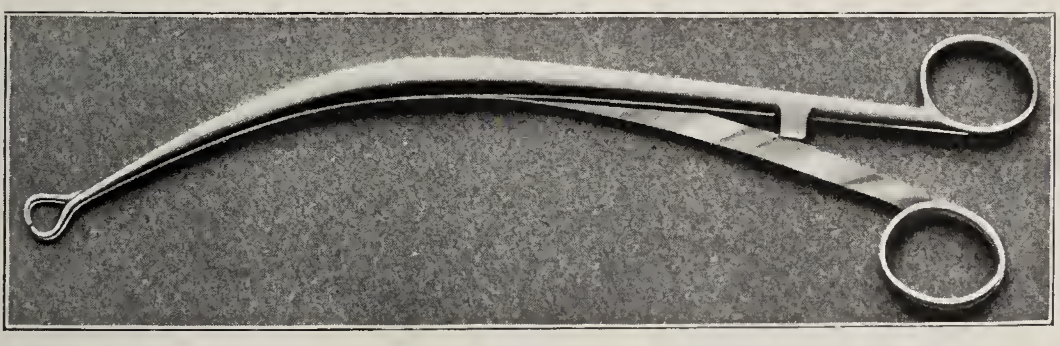

Fig. 644.—Uterine Volsella.

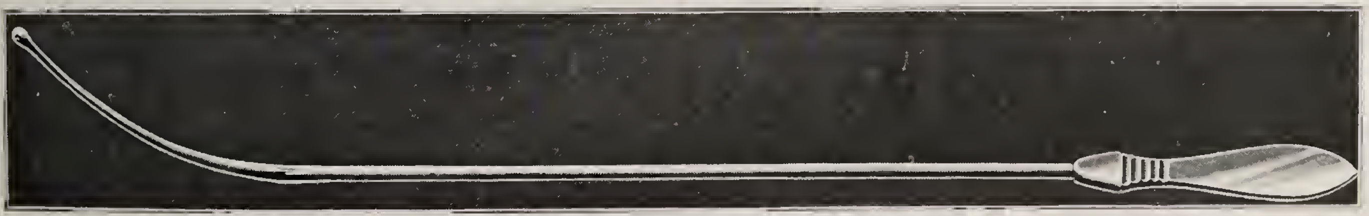

Fig. 645.—Intrauterine Probe.

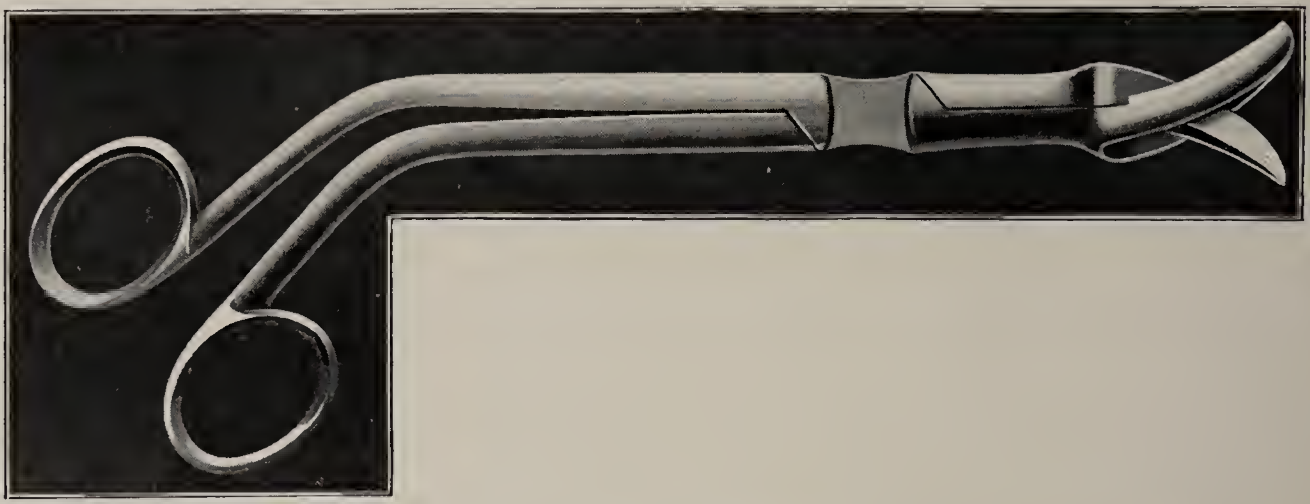

Fig. 646.—Skene's Hawk's-bill Scissors.

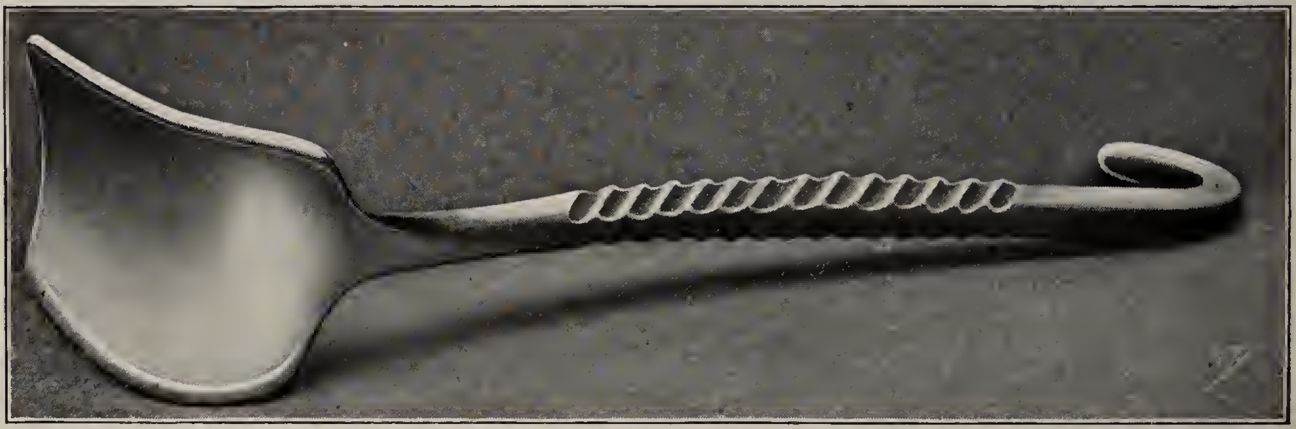

Fig. 647.—Lateral Vaginal Retractor.

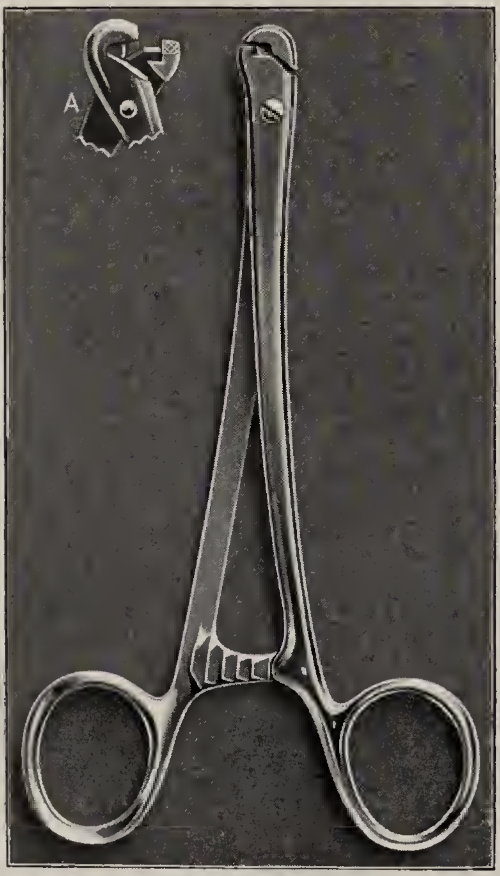

Fig. 648.—The Author's Universal Needle Forceps.

of the tear is now thoroughly cut away, either by Skene's hawk's-bill scissors (Fig. 646) or by the scalpel, and the denudation completed by cutting with the scalpel the margins of the cervical canal and paring the surface of the tear to the sharp line thus formed. At this stage of the operation more working room may be gained by the use of the lateral vaginal retractor (Fig. 647). In closing the gap Emmet's wire needles with cutting point are employed, held with a suitable needle-holder (Fig. 648). Chromicized catgut is used. The needle enters near the angle of the gap on the vaginal surface of the posterior lip of the cervix and emerges at the edge of the mucous membrane of the canal. It then enters at a point on the mucous membrane of the anterior lip, corresponding to the last named, and emerges on the vaginal surface of the anterior lip. The needle enters and finally emerges on completion of the suture, about $\frac{3}{16}$ of an inch from the edge of the freshened tear, and should be passed as nearly as possible parallel to each surface to be approximated. From three to five sutures on each side are usually required (Figs. 649 and 650). All the sutures are passed before any are tied. After they are tied, a sound is passed to make certain that the cervical canal is free for drainage, when the ends of the sutures are cut short and the vagina packed with sterile gauze. The patient may be permitted to urinate voluntarily. No vaginal douches are to be used. The chromicized gut sutures last sufficiently long to insure complete union; they do not require removal.

If **hypertrophic** and **hyperplastic conditions** exist after laceration of the cervix uteri, these should be treated preliminarily by hot douches and glycerin tampons on alternate days, and by rest in the recumbent position for a considerable portion of each day; if these measures do not suffice, the operation of **amputation of the cervix** should take the place of trachelorrhaphy. This is done most conveniently by the method of dividing circularly the mucous membrane of the cervix and then deepening this cut and grasping the cervical tissues of the stump as the operation proceeds, to prevent retraction (Emmet). In applying the sutures, the lateral angles of the canal are grasped by tenacula, and, from a point commencing on the woman's left, the posterior vaginal mucous membrane is first grasped by the needle, then the tissues of the stump, and finally the anterior vaginal mucous membrane (Fig. 651). On reaching the canal the needle perforates the mucous membrane of the latter and the suture is then turned back for tying. The anterior lip is attached to the canal in the same manner. Two or three sutures may be required posteriorly and the same number anteriorly. Or, all the sutures may be utilized to secure the approxi-

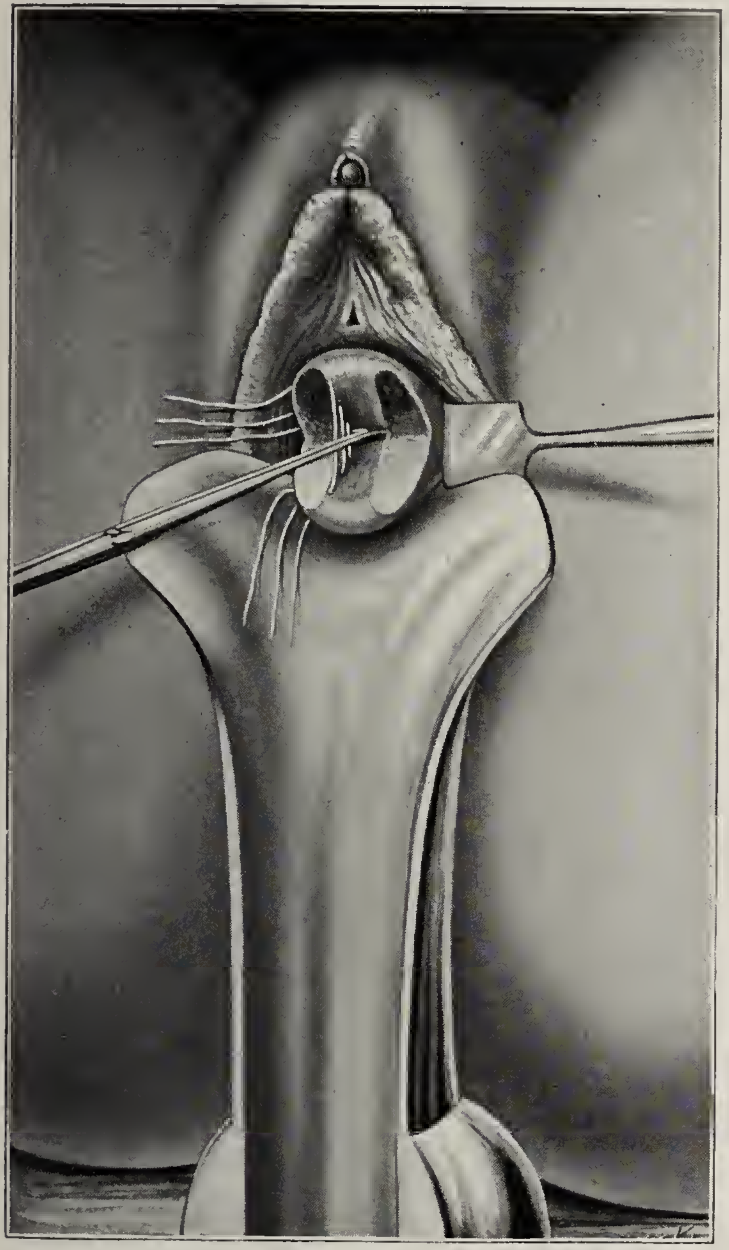

Fig. 649.—Trachelorrhaphy.
Uterus drawn down, tear denuded, and sutures applied to one side.

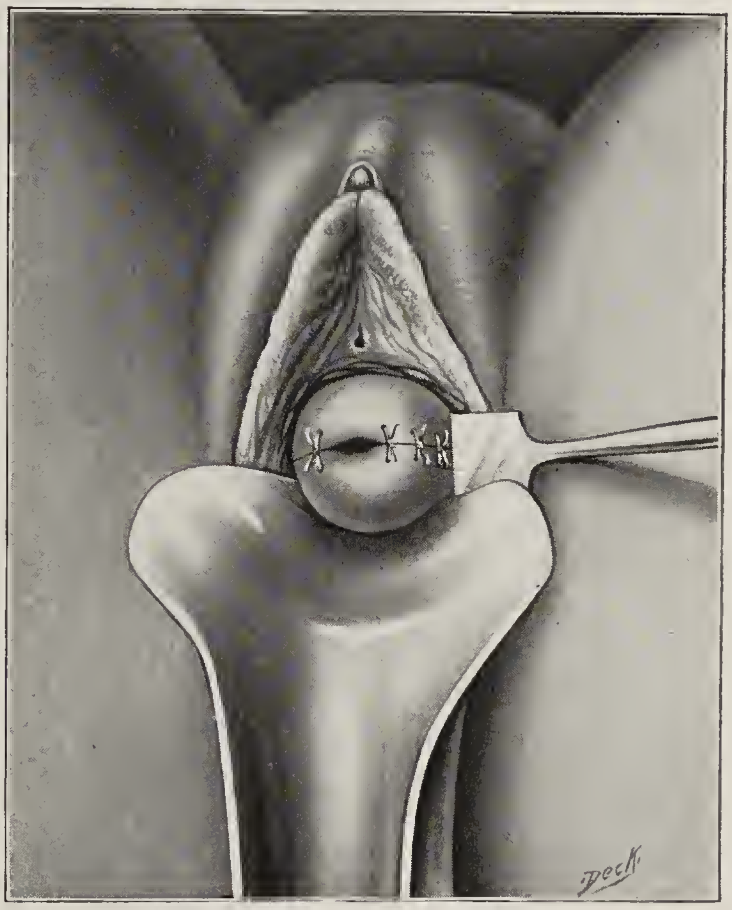

Fig. 650.—Trachelorrhaphy.
Appearance of cervix after suturing.

mation of the vaginal with the cervical mucous membrane (Fig. 652). The after-treatment is the same as in trachelorrhaphy.

Operative laceration of the cervix uteri usually occurs near the internal os. It is due either to the employment of an unjustifiable amount of force and too great dilatation or to a diseased condition of the cervical tissues. It is recognized by the sudden giving way of the parts and the occurrence of bleeding. The latter can usually be arrested by tamponing. If free and persistent, the uterine artery may be torn, in which case it may be necessary to open the abdomen to find the source of the bleeding. Exceptionally it may become necessary to remove the uterus before the bleeding can be arrested.

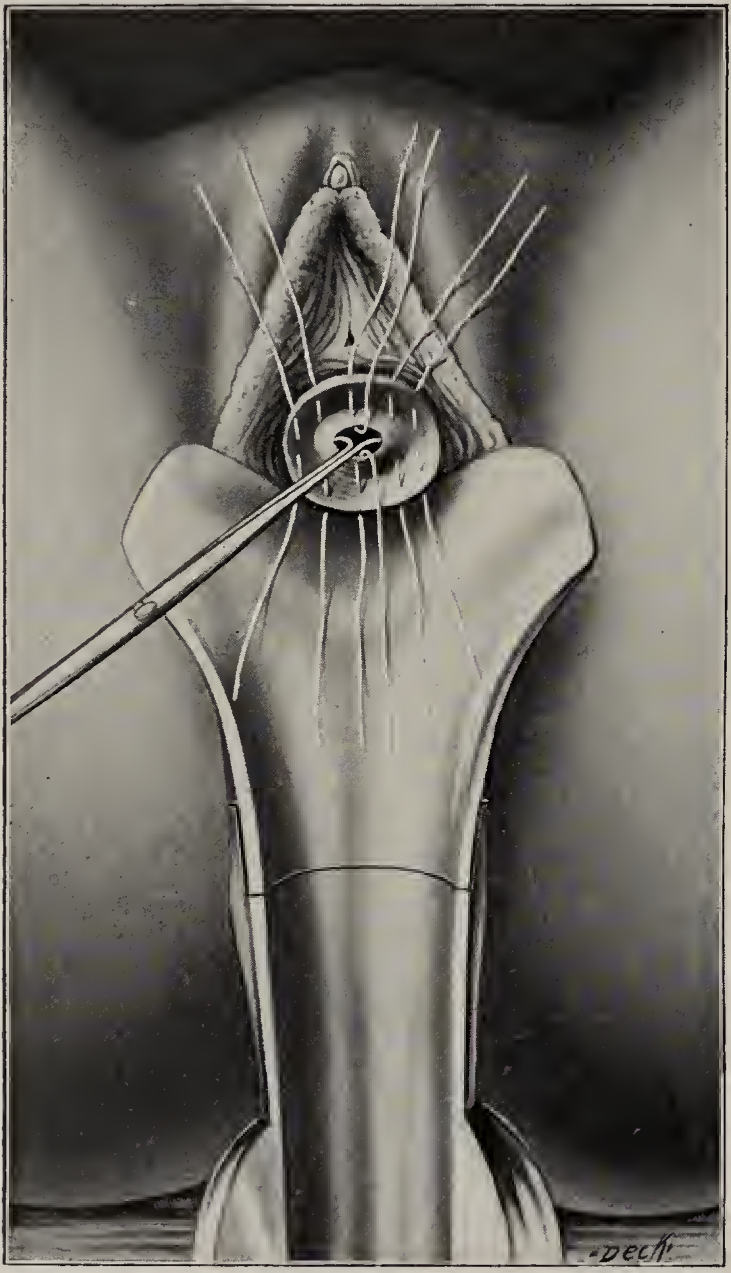

Fig. 651.—Emmet's Method of Amputation of the Cervix Uteri.

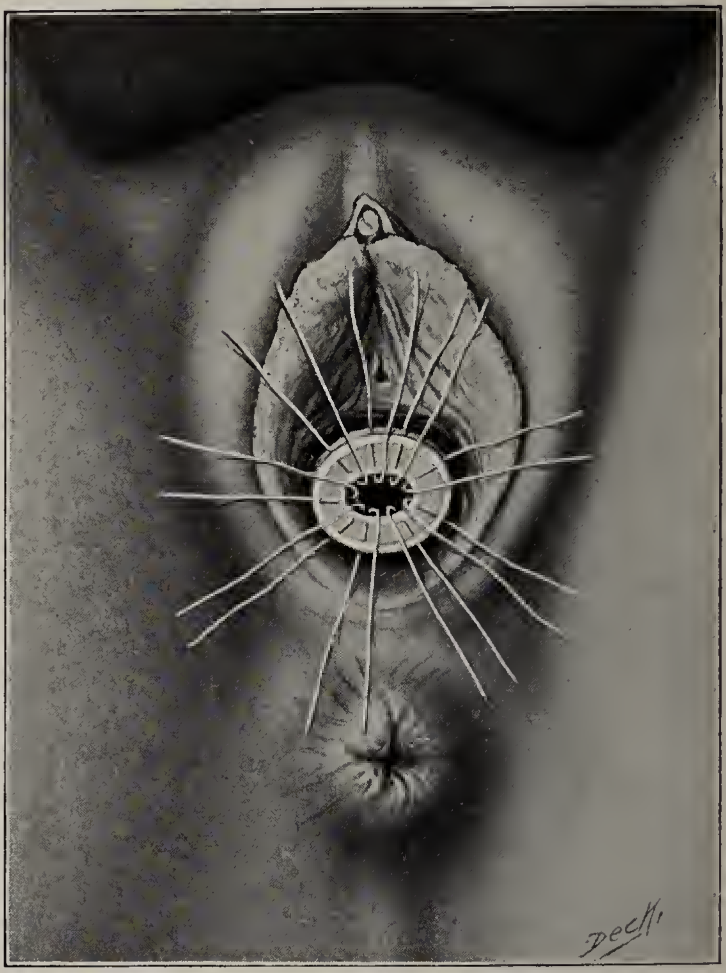

Fig. 652.—Amputation of the Cervix Uteri. The illustration shows another method of arranging the sutures that secure the approximation of the vaginal with the cervical mucous membrane.

Rupture of the Uterus.—This is an accident occurring during labor. It may be due to any condition that interferes with the normal descent of the child, the body and fundus ascending as the labor progresses, or to any weakening influence on the uterine wall. In addition to dystocia from conditions referable to the child, tumors of the body of the uterus, distortions of the pelvis, and cancer of the cervix are among the causes.

The rupture may be complete or partial. When complete, there is profound shock, a cessation of the uterine contractions, and recession of the presenting part of the child; there is also an abnormal mobility of the uterus; the solid feel of the fundus disappears or the latter is tilted to one side; in lateral rupture the normal contour of the corresponding uterine quadrant is lost; an emphysematous crackling is felt at the seat of rupture (Ludwig); there is a discharge of blood from the vagina and the cord is frequently prolapsed. When partial, there is a temporary interruption of the labor pains, slight shock, and persistent postpartum bleeding.

Treatment.—The uterus must be emptied at once. The delivery may be by **forceps, version** or **craniotomy,** or **morcellement.** Abdominal section should be performed in all cases for the purpose of arresting the hemorrhage, closing the rent, and effecting delivery when this cannot be accomplished *per vias naturales*. The abdominal cavity should be cleansed and filled with saline solution at 110° to 120° F. before it is closed. The patient should be given an intravenous saline infusion. In some cases it may be necessary to remove the uterus (Porro). In this, as in operations on the pelvic organs in general conducted by the abdominal route, the elevated pelvis position (Trendelenburg, Fig. 653) is of special utility in removing the intestines from the operative field.

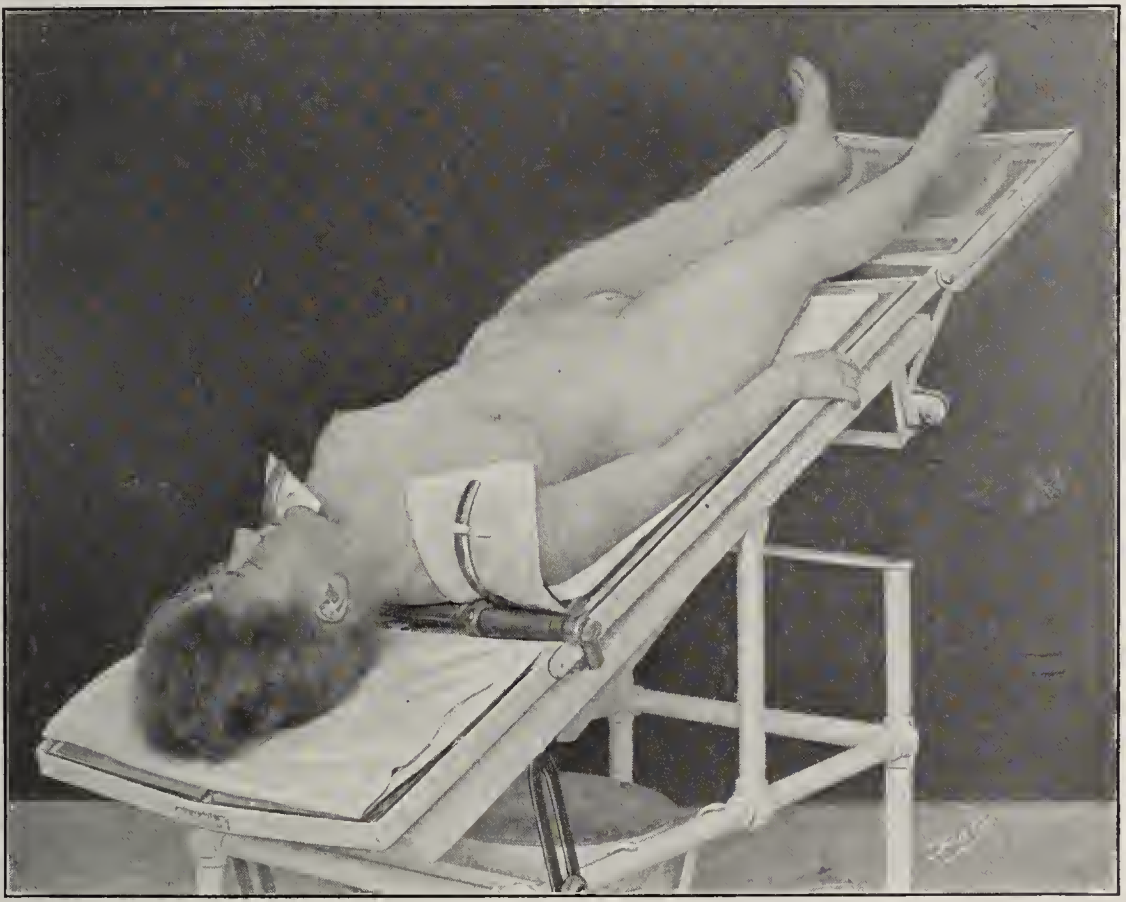

FIG. 653.—THE TRENDELENBURG POSITION.

Wounds of the Uterus.—These may result from the careless or criminal use of the uterine sound, or similar instrument, as well as from the use of either this or the curet employed for a legitimate purpose. Perforation of the uterine wall may occur in the hands of an experienced operator while he is dilating or curetting the uterus, from a diseased condition of the uterus itself. This is particularly true of cases of puerperal infection and of cases of subinvolution.

When the injury results from an attempt at criminal abortion, the unclean instruments employed usually give rise to sepsis, which may prove fatal.

The **diagnosis** is based on the fact that the sound or curet passes beyond the previously ascertained limits of the uterine cavity.

The **treatment** of perforations of the uterus will depend on the conditions present. In a septic case it is safer to open the abdomen, repair the perforation, and cleanse the peritoneum. Nonseptic cases with a small perforation should be carefully watched and abdominal section performed on the first appearance of threatening symptoms. In the meanwhile the patency of the cervix should be maintained by a drainage-tube and the vagina packed with sterile gauze. The use of the douche should be avoided. In the case of a large perforation, as, for instance, one made by a curet, the possibility of the protrusion of a loop of intestine or a portion of omentum should be borne in mind and the damage repaired through an abdominal incision. It may even be necessary to perform a hysterectomy under these circumstances. Injury of the intestine imperatively demands abdominal section and repair of the injured gut.

Gunshot wounds of the pregnant uterus have been recorded. Labor pains set in and the uterine contents are expelled. In the non-impregnated uterus contractions are followed by the expression of clots. In either case the abdomen should be opened at once, particularly in the case of the gravid uterus, even though the fetus has been expelled, for the reason that amniotic fluid may have been forced through the wound of the uterus into the peritoneal cavity.

Cattle-horn wounds of the pregnant uterus occasionally occur in farming districts. The wound of the uterus may be sufficiently large to permit the escape of the entire uterine contents into the peritoneal cavity. Such injuries are not necessarily fatal, as regards either mother or child. The **treatment** consists in following the technic of elective cesarean section (see page 405).

Foreign bodies, such as hairpins, broken-off catheters, and other instruments used to produce abortion, have been found in the uterus. Strips of gauze accidentally left in the course of treatment and the stem of an intrauterine pessary are also occasionally encountered. Tents used for dilating the cervix have slipped into the cavity of the uterus. The fragments of a broken glass catheter used for irrigating the uterine cavity may become embedded in the walls of the uterus (Mittermaier, quoted by Reed). Whenever possible the foreign body should be removed through the dilated cervix. In cases of impacted bodies hysterectomy may be necessary.

Endometritis.—This is usually associated with **metritis,** owing to the intimate anatomic relations of the endometrium and myometrium. The most important changes, however, are found on the surface of the former. The disease is generally the result of a mixed infection, though in some cases it may be due in the commencement to the presence of the gonococcus of Neisser. The so-called **catarrhal endometritis** is a simple hyperemia (Reed). In elderly women a discharge of thin, foul-smelling pus is sometimes found to escape from the uterus on dilating the cervix (senile suppurative endometritis).

Causes.—Endometritis is always due to infection. In the case of mixed infection the infectious material may be carried above the internal os by mechanic means, such as unclean instruments. Lacerations of the cervix and a chronic dilatation of the canal are predisposing causes. **Uterine** displacements, particularly prolapsus, favor the occurrence of the infection. Degenerative changes occurring in tumors of the uterus may be a source of infection.

Symptoms.—In the simple form in which the surface epithelium and mucous follicles are alone involved, the discharge varies from a clear and viscid to a mucopurulent character. It may occasionally be stained with blood. Dysmenorrhea is not uncommon. In long-standing cases both menorrhagia and metrorrhagia may be present. In women at or near the menopause these are due to degenerative changes in the endometrium (**fungous endometritis**). Sensibility of the fundus is sometimes present.

The **diagnosis** is established by dilating the cervix and removing the intrauterine tissue by means of the sharp curet. In hemorrhagic cases the suspicion of malignant disease must be entertained.

Treatment.—The best nonoperative treatment consists in slightly dilating the cervical canal, thoroughly cleansing the uterine cavity with strips of narrow gauze, and packing it with a narrow ribbon of gauze saturated with 95 per cent carbolic acid (Reed). If the vaginal mucous membrane is accidentally touched with the carbolic acid, the latter should be at once neutralized with alcohol. The vagina is packed with glycerin tampons. The treatment is repeated every second day; three or four applications usually suffice in simple cases. This and all other intrauterine medications are of absolutely no avail in cases of fungous endometritis with associated hemorrhage. Nothing short of a thorough removal of the thickened lining of the uterine cavity by means of the sharp curet will suffice in these cases.

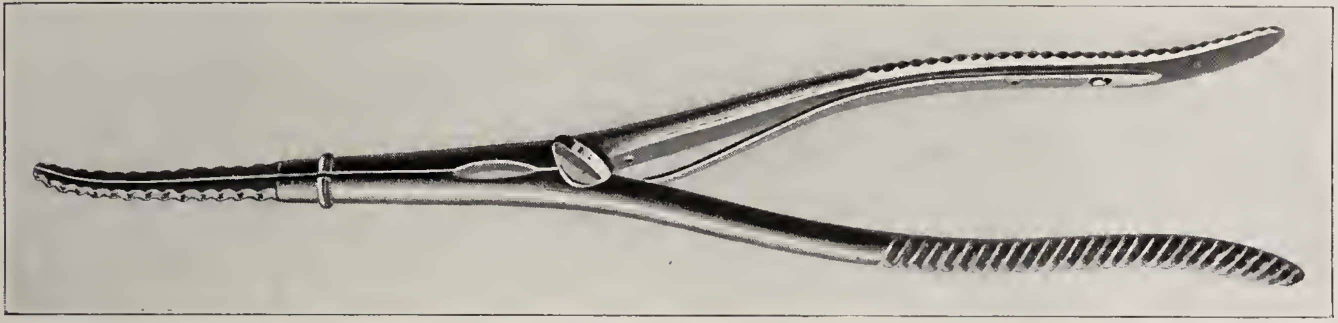

Fig. 654.—Small Cervical Dilator.

The **operative treatment** of endometritis consists in a thorough curettage followed by antiseptic applications. The emulsion of iodoform is used by some surgeons; others prefer to pack the uterine cavity with iodoform gauze. Thorough irrigation of the uterine cavity by means of the borosalicylic solution of Thiersch, after curettage, answers the purpose in most cases. The preliminary dilatation of the cervical canal is best effected by the small cervical dilator (Fig. 654), followed, if necessary, by the instrument devised by Goodell (Fig. 655), and the curettage by any of the sharp curets of suitable size and shape. The dilatation of the cervical canal should never be carried beyond the actual requirements of the case.

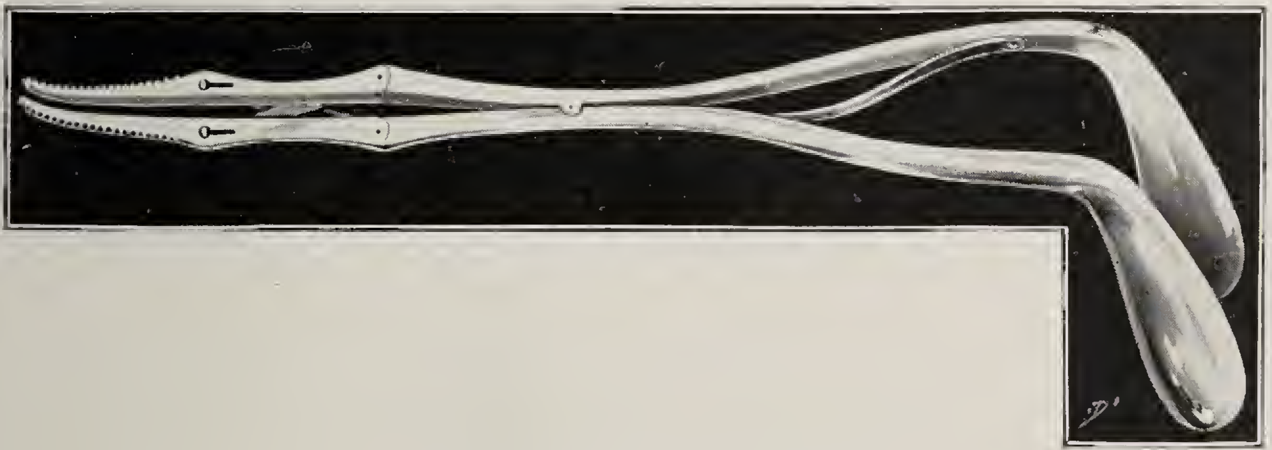

Fig. 655.—Goodell's Dilator.

In cases of **gonorrheal endometritis,** during the acute stage, the infection may be limited to the cervical canal, and hence every care should be taken to prevent diffusion of the infectious agents. The cervix should be exposed by a speculum, the canal cleansed, and a 5 per cent solution of protargol applied. The vaginal surfaces are treated with a 2 per cent solution of the same agent and packed with gauze moistened with the same. The treatment is repeated every second day. In chronic cases, in order to prevent extension to the Fallopian tubes, the infection should be eradicated by curettage and subsequent packing of the uterus with a gauze strip saturated with a 5 per cent solution of protargol.

Streptococcus infection of the uterus is the ordinary condition which obtains in **puerperal fever (streptococcus metritis)**. The distended lymphatics and open blood-vessels at the site of the placenta serve for the reception of the poison, which is speedily taken up and transported to the system at large. Infectious thrombophlebitis of the uterine sinuses occurs, followed by the breaking-down of the thrombus and the general dissemination of emboli containing the microorganisms. Foci of suppuration form in the body of the organ and large abscesses sometimes result. The peritoneum becomes involved (**streptococcus peritonitis**), the infection being conveyed through the lymph-channels from the interior of the uterus.

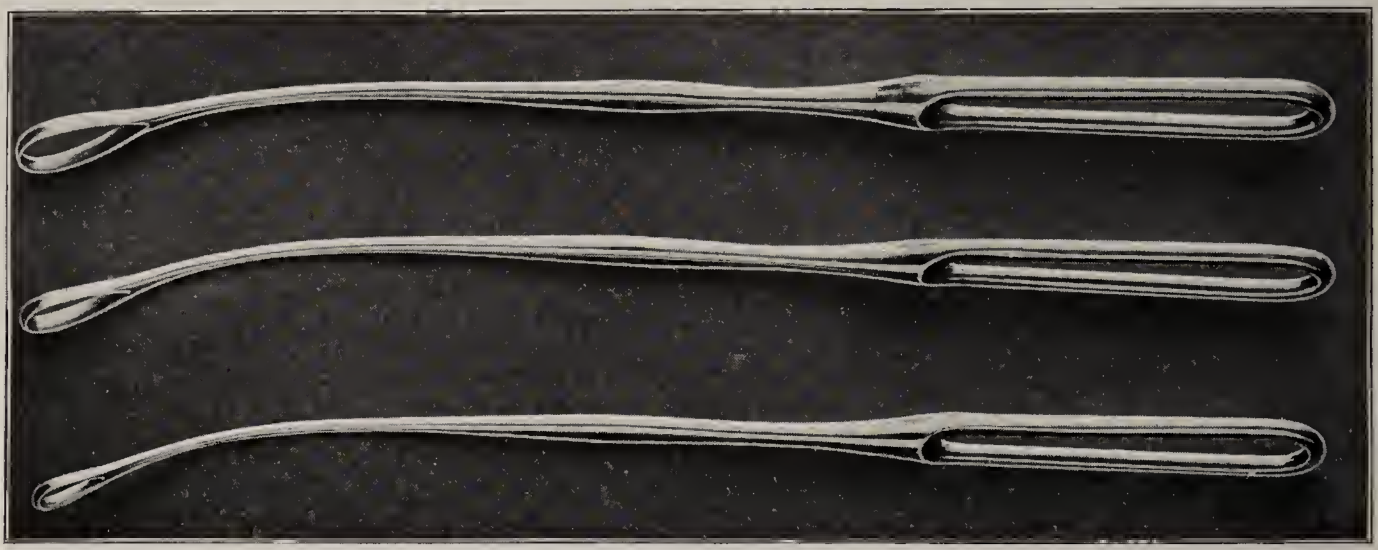

Fig. 656.—Uterine Curets.

The **symptoms** are a pronounced chill, preceded or followed by fever; temporary arrest of the lochia, a dark, offensive, and slightly viscid vaginal discharge taking its place. Irregular chills, an erratic temperature curve, marked exhaustion, and cold, clammy perspiration are marked features of the disease.

The **surgical treatment** consists in, first, early and thorough curettage in order to arrest the infection. This should be performed at the first sign of disturbance. The operation is followed by a uterine irrigation of a 1:2000 sublimate solution and the packing of the uterus with iodoform gauze soaked in glycerin. Second, should these measures fail and the symptoms persist without amelioration, no time is to be lost, but complete removal of the uterus must be practised at once. The abdominal route is to be chosen. The uterine cavity and vagina are to be thoroughly irrigated beforehand with a 1:2000 sublimate solution and packed with gauze wrung out of the same strength of solution made with 50 per cent alcohol.

Hysterectomy for streptococcus metritis, to be of use, must be performed early in the disease. It can be of no avail after extensive thrombophlebitis with dissemination of septic emboli has occurred.

Tumors of the Uterus.—Neoplasms of the uterus occur with relative frequency. A convenient arrangement for purposes of clinical study is their division into (1) benign growths; (2) malignant growths.

Benign Tumors.—Of these, the most common are those variously known as **fibroma, fibromyoma,** and **myoma.** These growths are composed of connective tissue and muscle tissue combined, either of which may predominate in the formation. A rare form, known as **adenomyoma,** contains gland elements. Fibromyomas usually grow from the myometrium, rarely from the cervix. They may be multiple or single and may assume a spheric or an ovoid shape. They vary in size from a millet-seed to enormous proportions. They develop in the direction of least resistance and are designated as **subserous, interstitial,** and **submucous.** Those springing from the cervix develop according to their situation, either in the direction of the vagina or in the retrocervical connective tissue. The causes of fibromyoma of the uterus are unknown.

Degenerative changes occur in fibromyomas, such as **atrophy, calcareous changes, fatty degeneration** and myxomatous degeneration. **Inflammation,** followed by **necrosis** or **sloughing,** also occurs. **Sarcomatous degeneration** occasionally takes place. **Carcinoma** may develop in adenomyoma. Mixed tumors are formed through metaplasia of myoma, or extension of a proliferating growth from the neighboring tissues into a myoma.

Symptoms.—The most prominent symptoms of fibromyomas are **hemorrhage** and **pain.** Attention is first called to the disease, as a rule, by the occurrence of profuse and prolonged menstruation. Anemia and profound general exhaustion are commonly present. Pain, the result of pressure or complicating inflammatory lesions of the adnexa, is a prominent symptom. Bladder symptoms are present in advanced cases, and in some cases are not infrequently complained of early in the disease.

Diagnosis.—Fibromyomas may occur in women of any age or race. They are rarely observed before the occurrence of menstruation and very infrequently develop after the menopause. The most common age at which they occur is between thirty and forty. Negroes are attacked more commonly than white women. Bimanual examination discloses the presence of a growth attached to the uterus. Irregularity of outline, firm consistency, and nodular character of the tumor, as felt by abdominal palpation, taken in conjunction with the history and the fact that the growth is traceable to the uterus as shown by conjoined or bimanual manipulation, confirm the diagnosis. The presence of pregnancy should be excluded; it must be borne in mind, however, that pregnancy may coexist with uterine fibromyomas. It is sometimes difficult to differentiate a small tumor in the posterior uterine wall from a retrodeviation of the uterus.

Treatment.—The only available and trustworthy treatment is operative. Efforts to arrest the growth and reduce the size of the tumor by removal of the ovaries have been successful; since the perfection of the technic of myomectomy and hysterectomy, however, the only indication for the less radical operation is the existence of such an extreme degree of anemia consequent on excessive loss of blood as to make either of the other operations hazardous.

Myomectomy.—Small pediculated tumors are easily removed by splitting the serosa and capsule near the base of the pedicle in the shape of two small flaps, and enucleating the tumor. In larger growths the hemorrhage may be prevented by the preliminary application of an elastic constrictor around the cervix and the pedicle transfixed with a double ligature and tied in two sections, after a cuff of peritoneum has been turned back. Even quite large non-pediculated interstitial myomas, when single, may be removed by myomectomy. If the bleeding is intractable after removal of the constrictor, the uterus must be removed at once. Otherwise the edges of the stump are sutured together and the cuff of peritoneum and capsule sutured over the stump. When no stump can be formed, the uterus tissues are drawn together by deep suturing with catgut, for the purpose of closing the gap and of arresting the hemorrhage. In conducting the enucleation blunt dissection with the handle of the scalpel aided by the fingers should replace cutting as far as possible. The uterine cavity should be curetted beforehand in order that drainage through the vagina may be instituted by passing a strip of gauze from the site of the tumor through the uterine cavity, in case the latter has been invaded during the operation. The presence of multiple tumors is an indication for hysterectomy.

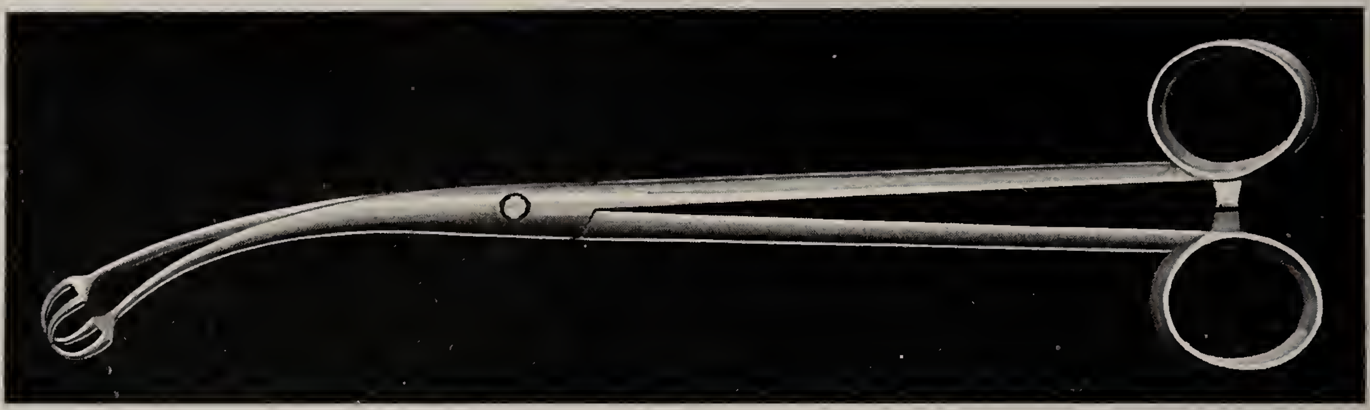

Fig. 657.—Double Tenaculum Forceps.

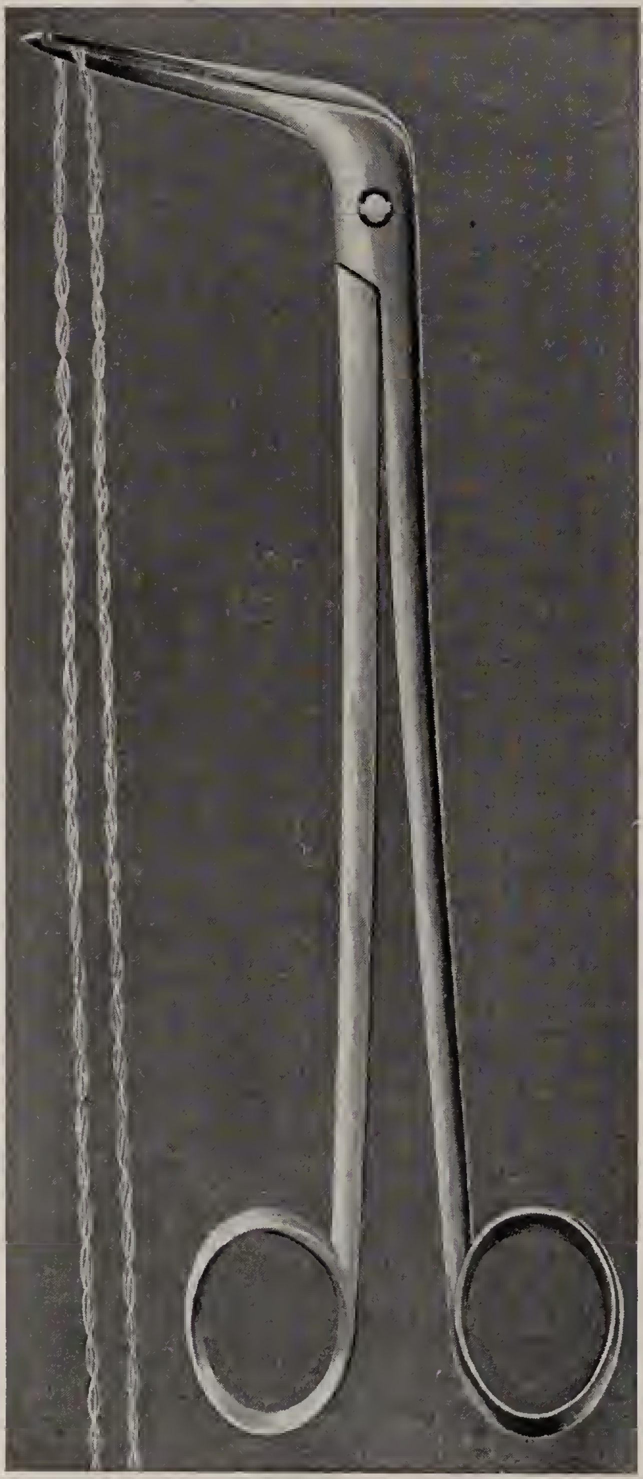

Fig. 658.—Braided Catgut Ligature and Ligature Carrier.

Supravaginal Hysterectomy.—Whenever the adnexa are healthy, these should be preserved and the operation conducted in a subperitoneal manner. The uterus is held strongly forward in the abdominal wound by a heavy tenaculum forceps (Fig. 657). Each broad ligament and Fallopian tube is ligated in turn in two places as close as possible to the uterus with braided catgut (Fig. 658), so as to secure the ovarian arteries, and cut between. Two peritoneal flaps are now formed by transversely incising the serous covering of the uterus, the anterior flap including the bladder. The posterior flap is stripped backward to the rectum. These flaps of peritoneum are conveniently made by pushing the serosa back with a bunch of gauze grasped in a sponge forceps. The peritoneal covering of the lateral surfaces of the uterus is pushed back in the same manner, when the uterine arteries are brought into view. These are grasped by Pean's or Keith's forceps and the uterus cut away by a few strokes of the knife across the cervix. If there is much oozing from the cut surface of the cervix, this is touched with the thermocautery. The uterine arteries and other bleeding points that have been secured by forceps are now ligated. Drainage is provided for by splitting the remains of the cervix directly backward sufficiently to permit the passage of a finger-sized drainage-tube into the vagina. This tube should be self-retaining (Fig. 659). The peritoneal flaps are now to be approximated by catgut sutures over the cut surface of the cervix, this, as well as all other raw surfaces, being turned away from the peritoneal cavity and placed in the retroperitoneal space. The tubes and ovaries, however, are left inside. The abdominal wound is closed and the vaginal tube dressed with sterile gauze. The drainage-tube is removed about the third day, after which a daily douche of boric acid solution is used, the vagina being kept packed with sterile gauze in the interval.

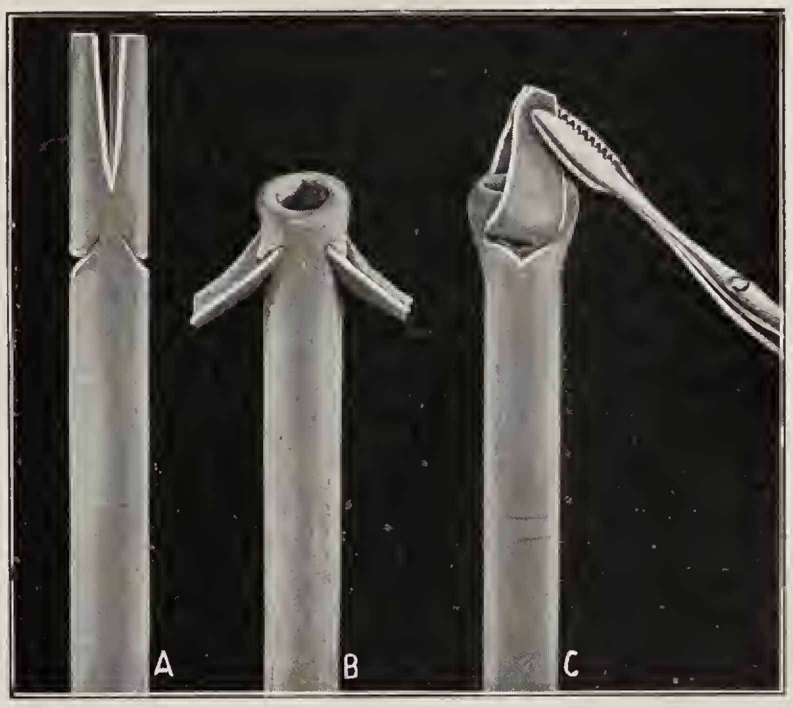

Fig. 659.—The Self-retaining Drainage-tube.

A, Rubber tube shaped ready for forming the self-retaining wings; B, the split lateral portions of the tube reversed and passed through the openings on the side to form the wings; C, the tube grasped by the forceps ready to be placed in position.

Panhysterectomy.—The technic of the operation of complete extirpation of the uterus is similar to the foregoing up to the point of the section of the cervix. Even this may be accomplished, the latter being readily dissected away after the body of the uterus and the tumor have been removed. This method, namely, the removal of the body of the uterus first and then the removal of the cervix, should not be undertaken, however, in malignant disease.

Special care is necessary in performing this operation to avoid injury to the ureters. These should be identified whenever possible. When they are not isolated, the operator should carefully inspect all tissues before dividing them. In cases of malignant disease injury to the ureter sometimes happens. The divided ureter should be immediately implanted into the bladder.

In freeing the cervix from the vagina, the cut edges of the latter are grasped with long Pean forceps until the section is completed; any bleeding vessels that appear may be secured at the same time and ligated afterward. If the uterine arteries have been previously tied, most of the bleeding will come from the azygos artery of the vagina posteriorly. Injury to the bladder and vagina must be carefully avoided. On the completion of the operation a wide strip of sterilized gauze is packed into the vagina from above, its upper end being laid in folds above the cut edges of the vagina. The vesical fold of peritoneum is now sutured to the posterior peritoneal flap, the toilet of the peritoneum completed, and the abdominal incision closed.

Polypoid growths of the uterus, when small, may be removed by simple torsion, combined with traction, by scraping them off with a sharp curet or by cutting across the pedicle with long blunt scissors. Large polypi are best removed by means of the wire écraseur after the cervical canal has been thoroughly dilated and the point of attachment identified. Piano wire is the most easily applied and manipulated. The cut surface, if accessible, should be cauterized with the thermocautery. Bleeding, unless arrested by the cautery, will usually yield to a hot intrauterine douche and the packing of the cavity with iodoform gauze. The cavity of the uterus should always be explored for other growths.

Adenoma uteri is a malignant degeneration of the endometrium. In typic cases it consists of a diffuse and irregular thickening of the mucous membrane. It would seem to have its origin in a simple glandular hypertrophy of the endometrium, the acquired malignant features tending toward the carcinomatous type. Metastases occur late, if at all.

The **symptoms** are those of chronic endometritis, plus hemorrhage and intervening watery discharge, and pronounced pain and tenderness. These symptoms may all disappear for a time, the patient in the meantime maintaining fair health. They may then return, perhaps more pronounced than ever. The clinical course is slow.

The **differential diagnosis** between simple glandular hypertrophy and malignant adenoma is difficult and often impossible. This is true even with reference to microscopic examination of the uterine scrapings obtained.

Treatment.—All cases of adenoma of the body of the uterus should be subjected to total extirpation of the organ, without reference to the microscopic findings as to malignancy or nonmalignancy. If the uterine scrapings show adenoma, the sooner a panhysterectomy is performed the better. Above all things, repeated curettage is to be avoided, and cauterization, whether by the galvanocautery, the thermocautery, or chemic agents, is positively harmful.

Carcinoma.—Cancer of the uterus is rare before the age of thirty; it is most common between the fortieth and the sixtieth year. It is relatively more frequent in married women and in those who have borne children. It may spring from the cervix, either the free vaginal portion or the cervix proper, or from the body of the uterus.

Carcinoma of the portio vaginalis arises from the lips of the cervix and assumes the characteristics of polypoid **carcinoma (cauliflower excrescence).** Or there may be infiltration and hardening, with smooth hard surfaces. The vaginal walls become involved; the bladder is invaded from the anterior fornix. The rectum is rarely involved. The iliac lymphatics are the seat of carcinomatous infection. In the cervix proper it may commence as a circumscribed nodule or a diffuse infiltration. This is followed by ulceration and extensive loss of substance. Early in the disease extension takes place toward the body of the organ rather than on the vaginal mucous membrane; later on, the structures of the vagina become infiltrated. The bladder is often involved early; the rectum escapes until comparatively late. The iliac lymph-glands are infected.

Carcinoma of the Body of the Uterus.—This commences on the mucous membrane, either in a diffuse form or as a circumscribed carcinomatous process. The corpus uteri becomes infiltrated and enlarged in all directions. As the disease advances ulceration and sloughing set in and the uterine cavity enlarges. As the carcinomatous process reaches the peritoneal surface of the organ, adhesions to surrounding parts take place; these latter finally become involved in the disease. The bladder and rectum are usually involved later. Glandular involvement of the lumbar glands occurs.

Symptoms.—The disease is exceedingly insidious in its onset. In married women the first symptom is commonly the occurrence of slight bleeding following coitus. In other cases attention is first attracted to the uterus by a thin and watery, and perhaps slightly blood-stained discharge, which may or may not be fetid. This becomes more distinctly bloody and finally sharp hemorrhages set in. Pain is usually absent until the disease is well advanced.

Diagnosis.—An unusual flow of blood from the genitals of a woman in the cancerous age should always lead to an investigation. Involvement of the cervix, either in the shape of a nodular induration, a surface friable and bleeding on the slightest touch, ulceration with excavation, or cauliflower excrescence, may always be detected by digital examination. Cancer of the body of the uterus is comparatively rare and is diagnosed by microscopic examination of tissue removed for the purpose. In all early cases the aid of the microscope should be invoked. A discharge with a characteristically offensive odor is present and to the experienced surgeon is oftentimes quite sufficient to establish the diagnosis. The disease may be complicated by the presence of a myomatous uterus, by fibromyomas the seat of sarcomatous degeneration, or by pregnancy.

Treatment.—The successful treatment of cancer of the uterus depends, as in cancer elsewhere, on prompt and radical operative interference. In cases far advanced only **palliative treatment** is possible. This is carried out by removing by the sharp curet and scissors all the diseased tissues accessible. Care should be taken not to invade the bladder or rectum. The cavity left after thorough drying should be packed with cotton tampons dipped in a caustic solution of chlorid of zinc (one ounce to half an ounce of water). The tampons are squeezed dry and placed in position, after which the vagina is packed with tampons squeezed out of a saturated solution of bicarbonate of soda. The purpose of the latter is to afford protection to the vagina and external parts by neutralizing the chlorid of zinc as the latter flows down with the secretions from above. The tampons are removed in forty-eight hours and vaginal douches used. The slough from the cauterized surface separates in about ten days. The patient improves very greatly, but recurrence takes place in from six months to a year. The operation should be repeated immediately on the first sign of a return of the disease.

The **radical treatment** of cancer of the uterus consists in the removal of the diseased organ, together with the neighboring lymphatic glands, whenever possible. The methods practised at the present time are (1) vaginal hysterectomy; (2) abdominal panhysterectomy. While the first named is often given the preference over abdominal panhysterectomy in selected cases, the latter is more frequently employed. The anxiety of the surgeon to remove the disease as completely as possible will lead him to choose the route by which the most perfect access to all the involved tissues can be obtained. This without doubt is the abdominal route. On the other hand, it is asserted that the vaginal route serves to remove the uterus and appendages, and that the immediate mortality is comparatively low, while if the disease has extended beyond the uterus and lymphatic involvement has taken place, a cure cannot be expected, even with the access which the abdominal route offers. The mortality of the abdominal operation itself is considerably greater than that of vaginal hysterectomy. In cases in which the disease is discovered early, the uterus freely movable, and the vagina sufficiently capacious, the vaginal route should be chosen. On the other hand, in cases of late interference or early cases in which adhesions prevent the uterus from being drawn down, as well as in the unmarried or in women who have not borne children, the abdominal route should be chosen.

Vaginal Hysterectomy.—In septic cases the cervical canal is curetted and disinfected. In cases of broken-down carcinoma the sloughing portion should be removed and the parts cauterized with chlorid of zinc (*vide supra*) a week beforehand. With the patient in the lithotomy position, the perineal retractor (Fig. 643) is introduced. Both lips of the cervix are seized with the volsella forceps and the organ drawn down. Used in this manner, the forceps serve to close the os. A circular incision, made close to the cervix in nonmalignant cases, and at a distance of about three-fourths of an inch from the apparent boundaries of the disease in cases of carcinoma, embraces the cervix. The entire thickness of the mucous membrane is divided and the connective tissue in front of and behind the cervix is bluntly dissected up by the finger-tips covered with gauze. When the peritoneum is reached, this is seized with forceps, opened with the scissors, and the opening enlarged with the fingers. A gauze compress is pressed above the uterus to prevent the descent of omentum and intestine. Injury to the bladder in front, to the ureters on the sides, and to the rectum behind is to be carefully avoided in this stage of the operation. The separation of the bladder is completed in front and the ureters carefully cleared to each side by pushing them back. The cervix is drawn well to the left, the base of the right broad ligament sought, and the uterine artery identified by its pulsation. A Pean or Keith clamp (Fig. 660) is applied to the broad ligament so as to include the artery, or a braided catgut ligature may be passed with a large aneurism needle and tied. The sutures are now divided close to the uterus. The broad ligament of the opposite side, together with the corresponding uterine artery, is treated in the same manner. Firm traction being made on the uterus, a second clamp or ligature is applied on each side, and the tissues divided as before. A third clamp or ligature is applied on each side; the remainder of the broad ligament on the left side is brought down by the finger, hooked over its top, clamped or tied, and cut free. The organ now swings on a small portion of the right broad ligament, which is easily clamped or tied, and the uterus cut away. The stumps of the broad ligament are carefully inspected for bleeding. When ligatures are used, the vaginal vault and opening in the peritoneum are closed with a catgut suture and the vagina packed with sterile gauze. If forceps are employed, the suturing is omitted; the gauze is snugly packed between the forceps and extends sufficiently far to prevent protrusion of the intestine. A vulvar pad is then applied. The forceps remain *in situ* for two days; the gauze is not disturbed for three or four days. The parts are thereafter to be douched twice daily with boric acid solution. (For Abdominal Panhysterectomy, see page 371.)

Sarcoma of the Uterus.—This is of much less frequent occurrence than carcinoma of the uterus. It usually occurs in middle life and in elderly women, though it has been observed in very young children. It may spring from the mucous or muscular structures in the vaginal portion of the cervix, the cervix proper, or, more frequently, the body of the uterus. An apparently innocent polyp may be sarcomatous in character, its removal being followed by a markedly malignant growth of sarcoma. Sarcomas of a papillomatous type are sometimes found springing from the cervix. Sarcoma of the uterine wall rapidly infiltrates the muscularis and mucosa and quite commonly leads to a marked enlargement of the organ in all directions. The cavity is sometimes invaded in such a manner as to lead to a valvelike occlusion of the internal os, causing an intermittent discharge of accumulated serosanguinolent fluid. Destruction of the neoplastic tissues occurs as the result of hemorrhage. Fatty, hyaline, and colloid degenerative changes may also occur.

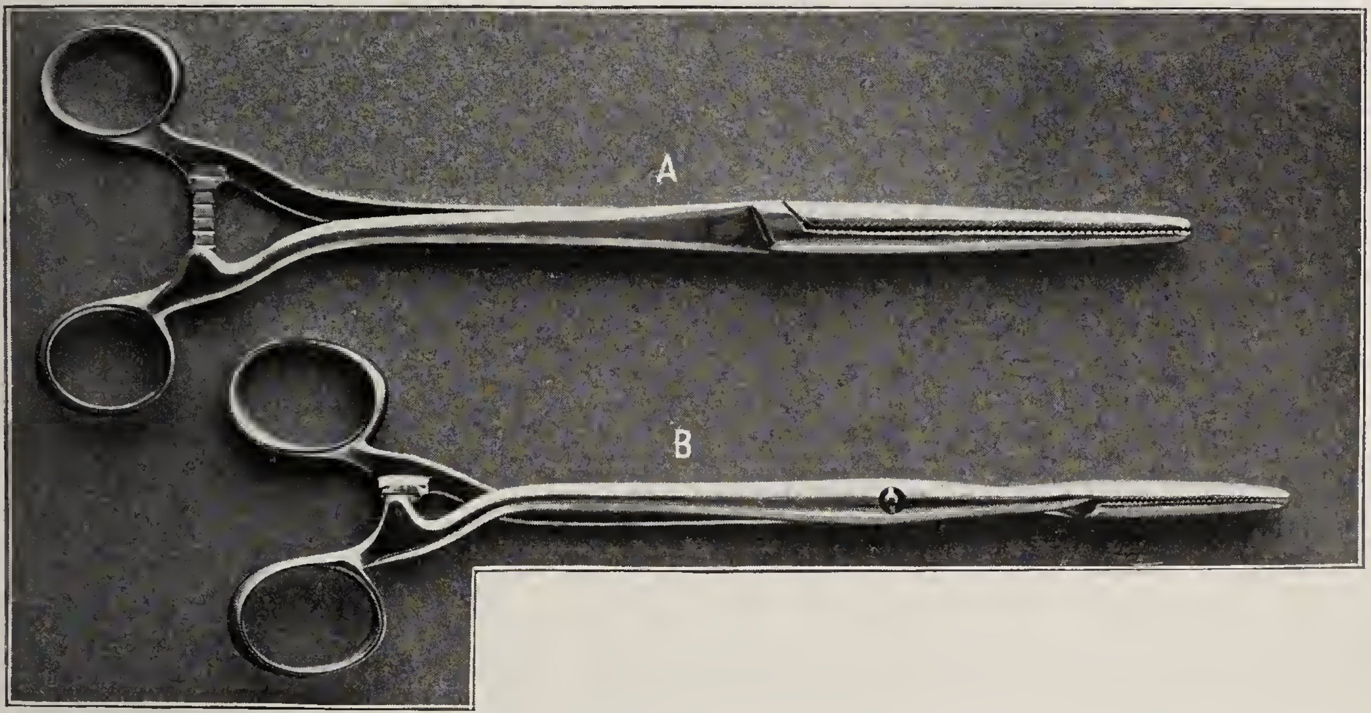

FIG. 660.—A, KEITH'S BROAD LIGAMENT CLAMP; B, PEAN'S LONG HEMOSTATIC CLAMP.

The **symptoms** are practically the same as those of carcinoma. There is the same hemorrhage, offensive discharge, and pain. Later in the disease the pain becomes a very prominent symptom. The growth of a sarcomatous uterus is more rapid than that of a carcinomatous uterus. A differential diagnosis, however, is impossible except by microscopic examination. Solid tumors of the uterus of rapid growth should always be looked on with suspicion, for the reason that, even if these are not sarcomatous from the beginning, they tend to undergo sarcomatous degeneration.

Treatment.—Early and complete extirpation of the uterus holds out the only hope of cure. Treatment by the mixed toxins of the **Streptococcus erysipelatis** and the **Bacillus prodigiosus** (Coley), injected directly into the tumor, induces certain degenerative and destructive changes in the tumor. The rapidity with which the toxin may pass into the circulation in the case of a very vascular tumor may induce collapse. This method of treatment should be reserved for inoperable cases.

Deciduoma Malignum (Syncytioma Malignum).—This is a form of malignant neoplasm springing from the epithelial layers covering the chorionic villi which project into the maternal decidua at the site of the placenta. The peculiar histologic feature of the growth is the absence of a newly formed integral stroma. It is made up of parenchyma alone, which consists of an extensive protoplasmic ground-substance or plasmodium, usually arranged in a network to produce an alveolar structure, and of numerous small polyhedral cells grouped in the alveoli.

The tumors may follow normal gestation or tubal pregnancy. About one-half of the cases, however, have occurred after mole pregnancy. They arise from the internal surface of the uterus as soft, spongy, villous, bleeding masses of varying size, resembling placental tissue. They may be single or multiple. They are also found in the Fallopian tube after pregnancy, but not in ovarian or abdominal pregnancies. They usually appear within a short time after delivery, an abortion, or the expulsion of a mole. The interval may be as long, however, as nine years (McCann's case).

They are of rapid growth, cause increase in the size of the uterus, and invade the wall of the latter in a manner resembling that of carcinomas. Metastasis occurs almost entirely through the venous channels, secondary growths resembling placenta occurring in the vagina, labia, lungs, kidneys, gall-bladder, thyroid, intestines, and sometimes in the brain. The tumor elements producing the secondary growths are rarely transplanted through the lymph-channels, as is the case in carcinomas, hence the pelvic lymph-glands are very infrequently infected.

The development of the tumor is marked by uterine hemorrhage, increase in the size of the uterus, and rapidly progressive anemia and cachexia. Portions of the growth may be passed from the uterus, these resembling placenta in appearance. Rarely no primary neoplasm is found in the uterus, the growth occurring in a distant organ, such as the kidney. The secondary growths are not large and appear rapidly in the localities named. Invasion of the lungs resembles disseminated miliary tubercle and is followed by hemoptysis and characteristic physical signs. Unless the primary growth is removed early, death takes place in from three to nine months.

DISPLACEMENT OF THE UTERUS

The uterus is a suspended, not a supported organ (Reed). It is held in position mainly by (1) the broad ligaments; (2) the round ligaments; (3) the uterosacral ligaments; (4) the attachments to the bladder. Its malpositions may be divided into (1) those occurring in a backward direction; (2) those occurring in a forward direction; (3) those occurring laterally; (4) prolapsus; (5) inversions. In **versions** of the uterus the longitudinal axis of the organ deviates from the normal plane, while in **flexions** the uterus is actually bent on itself.

Causes.—The most frequent predisposing cause is the damage done to the suspensory apparatus of the uterus in child-bearing. Under these circumstances the presence of puerperal metritis and subinvolution act as exciting causes. Another frequent cause is the presence of pelvic exudates and adhesions following pelvic inflammatory conditions. Constipation forcing the uterus downward, cooperating with overdistention of the bladder forcing the uterus backward, may produce a retrodeviation, or a sudden fall on the feet co-operating with distention of the bladder may likewise force the uterus backward. Occupations involving the lifting of heavy burdens tend to produce uterine displacements.

Pathologic changes in the organ consist of subacute or acute pelvic peritonitis, followed by adhesions; vascular engorgement, followed by enlargement and edema, and, in long-standing cases, by hyperplasia. The turgescence extends to the endometrium, leading to menorrhagia and metrorrhagia. In cases of flexion atrophy of the posterior uterine wall takes place from pressure on the concave surface, while compensatory hyperplasia takes place in the anterior wall. Relaxation of the uterine supports occurs, followed eventually by contractions and atrophic changes, in which, however, the round ligaments do not take part. The changes which take place in the suspensory apparatus of the uterus, coupled with the irregular distribution of exudations and adhesions, lead to various distortions of the organ.

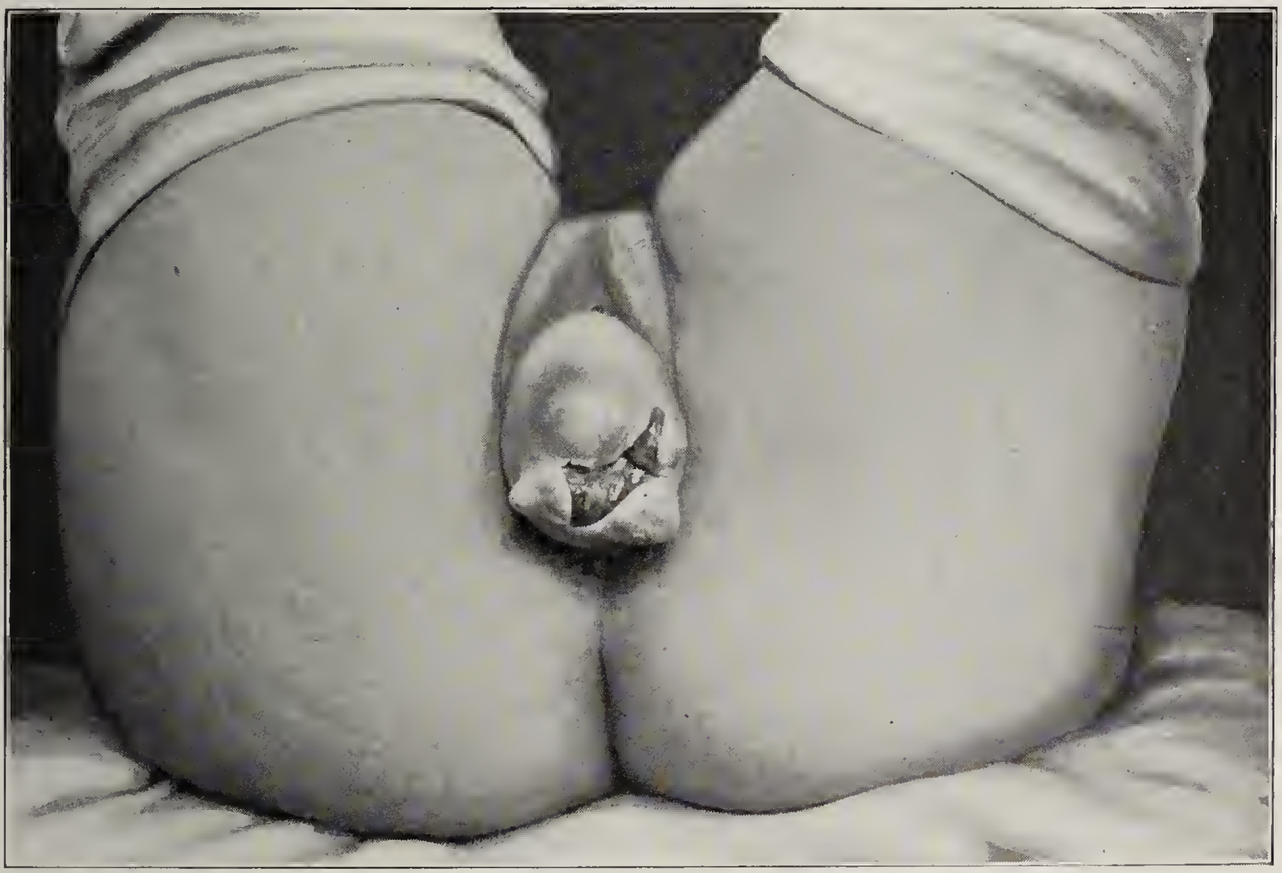

Fig. 661.—Prolapsed Uterus with Extensive Ulceration of the Cervix.

In **prolapse** of the organ the condition is either a part of a general descent of the abdominal and intrapelvic organs in women who have never borne children, or the result of the weakening of the uterine suspensory apparatus, relaxation of the pelvic diaphragm, and laceration of the floor of the pelvis following child-birth. The loss of support to the vagina, bladder, and rectum which the last named involves leads to descent of these parts and traction on the uterus, with consequent prolapsus (Fig. 661).

Treatment.—Pessaries only occasionally afford positive relief, still more rarely are they curative. Permanent benefit is to be derived in the cases of retrodeviations and prolapse by strengthening the natural supports or supplying new supports. In anteversion and anteflexion dilatation and curetting usually suffice to relieve the symptoms.

In the **treatment of retrodeviations,** replacement should not be undertaken until all acute inflammatory symptoms have subsided. For the latter, rest in bed and the use of salines, and hot douches and glycerin tampons on alternate days should be employed. In effecting replacement, the patient should be placed in Sims' position (Fig. 641) or in the knee-chest posture (Fig. 642) and the fundus pressed forward by the index-finger in the cul-de-sac. After replacement, the position may be maintained in a measure by a number of small glycerin tampons tied on a single string (chain tampon), introduced into the upper part of the vagina through a speculum.

The **operative treatment** of retrodeviations consists in (1) the shortening of the round ligaments; (2) vaginal fixation; (3) ventral fixation and ventral suspension.

Shortening the round ligaments by the extraperitoneal method (Alexander's operation) is indicated when no adhesions exist and when the uterus and adnexa are otherwise healthy. The uterus should be first curetted. The ligament is reached through an incision from one to two inches in length over the external abdominal ring. The inguinal canal is exposed, the intercolumnar fascia incised, and, if necessary the entire canal laid open. The round ligament is caught up on a strabismus hook (an ordinary button-hook will answer), isolated from the ilio-inguinal nerve and the surrounding connective tissue, and traction made until the canal of Nuck (the peritoneal investment of the ligament) is seen to be distinctly inverted. The amount of shortening necessary will vary in different cases. The pubic attachment of the ligament is now severed. The ligament on the opposite side is treated in the same manner. While traction is made on the ligaments, the latter are secured in their new position by a few chromicized catgut sutures, which are passed mattress fashion so as to secure the pillars of the ring and the round ligament. Additional sutures may be employed to close the canal if necessary. If the portion of ligament beyond the ring is sufficient, it may be utilized to secure additional firmness to the corrected position of the uterus by passing it beneath the skin and fat of the mons veneris to the opposite side. This is done by pushing a pair of hemostatic forceps beneath the structures mentioned, grasping the detached pubic end of the ligament of the opposite side, and withdrawing. This is repeated on the opposite side. A few sutures of chromicized catgut passed through the ligaments themselves serve to secure the latter in position. The ligaments lie parallel to each other in the tunnel thus formed. In women who have never borne children and in whom the round ligaments are not well developed, as well as in women past the menopause in whom they have undergone atrophy, there may be some difficulty in identifying them and in securing them without breaking after they are identified. In case of the latter accident the cord, if broken so that it cannot be secured otherwise, may be reached by opening the abdominal cavity at the internal ring. In case of coexisting inguinal hernia the round ligament will be found to occupy the same relations to the sac as the seminal cord to a congenital hernia in the male. In the after-treatment the patient is confined to her bed for ten days. It is usually recommended that she wear a pessary for three months. Except in cases of undeveloped or greatly attenuated round ligaments, this is unnecessary.

Intra-abdominal Shortening of the Round Ligaments (Wylie-Mann Operation).—This method may be applied when other diseased conditions make opening of the abdomen necessary. Each round ligament is folded twice on its long axis, the length of the folds being governed by the amount that it is necessary to take up. The two folds are then sewed together to the original stretch of ligament, the result being three thicknesses of ligament side by side. The suture material chosen should be silk.

The round ligaments may be shortened through the vagina (Goffe, Byford). The procedure is very much more difficult of performance however, than where the operation is performed as above described. **Vaginal fixation** of the fundus (Mackenrodt, Martin) is very little practised at the present time.

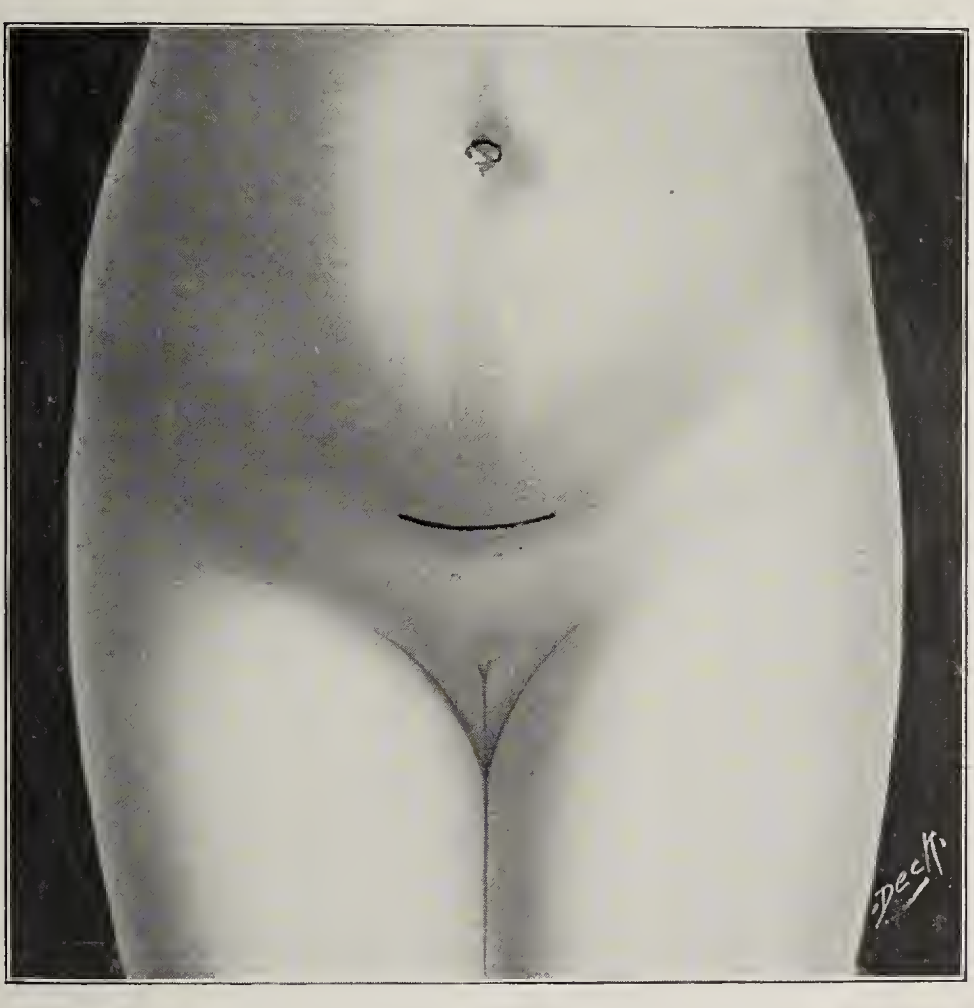

FIG. 662.—KÜSTNER'S TRANSVERSE INCISION.
The incision follows the normal skin-fold and the scar is concealed by the subsequent growth of the pubic hair.

Ventral Fixation.—This is done either by simply approximating the peritoneum covering the fundus to the parietal peritoneum, or by bringing the fundus out of the abdominal wound and sewing the peritoneum with silk to the body of the organ about half an inch below the fundus in front and on a slightly lower level behind. A few catgut sutures now secure the projecting fundus to the fascial and muscular structures of the abdominal wall. This last method is contraindicated where future pregnancy is possible. In the first named the simple approximation of serosa to serosa results in the formation of suspending bands of adventitious tissue, which finally stretch and may permit a retrodeviation.

Suspension of the Uterus to the Abdominal Wall.—This operation was introduced by the author in 1895.* The method recommended consists in the utilization of the remains of the hypogastric arteries and their peritoneal investment for the purpose of suspending the uterus. Either the vertical or the transverse suprapubic incision (Küstner) is employed (Fig. 662). Retraction is effected in the vertical direction (Fig. 663). The urachus is dissected loose to within a short distance of the bladder. Two transverse incisions, including the serosa and a portion of the thickness of the muscularis of the uterus, are made about three-eighths of an inch apart just posterior to the fundus. The intervening space is loosened and the urachus passed beneath the strap thus formed (Fig. 664). The urachus is then replaced and secured either by a separate row of sutures or by those employed to close the abdominal wound (Fig. 665). Subsequent pregnancy is neither accompanied by serious disturbances, or difficult labor, nor followed by relapse of the retrodeviation (Jacobson).†

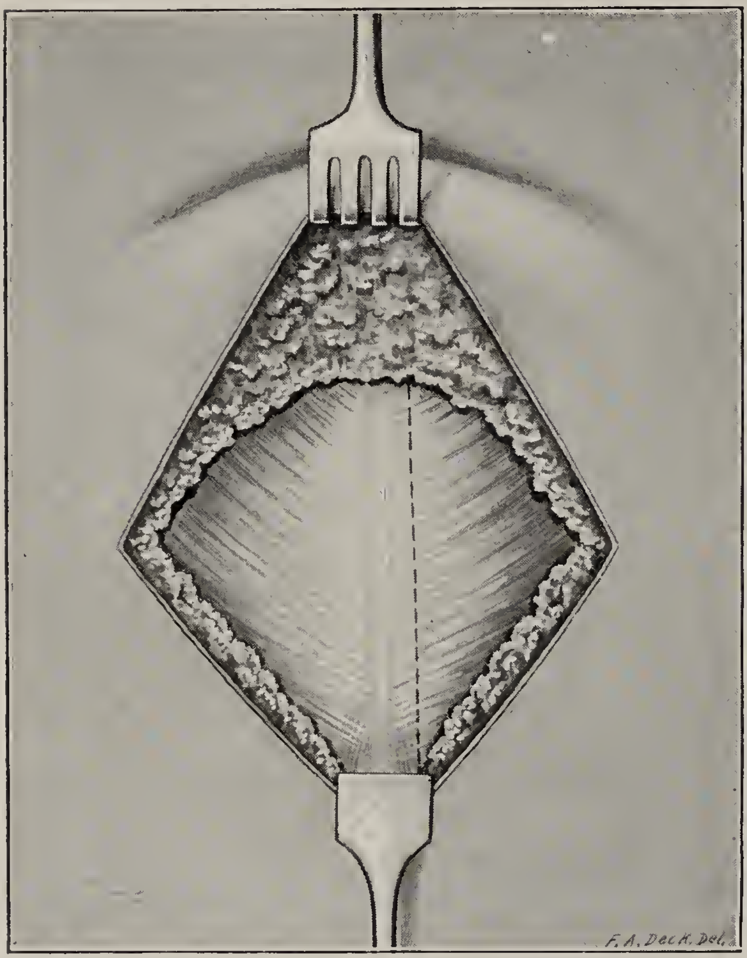

FIG. 663—SUSPENSION OF THE UTERUS.

Retraction of the upper and lower margins of the transverse incision of Küstner. The dotted line shows the line of incision of the aponeurosis for entering the abdomen through the rectus muscle.

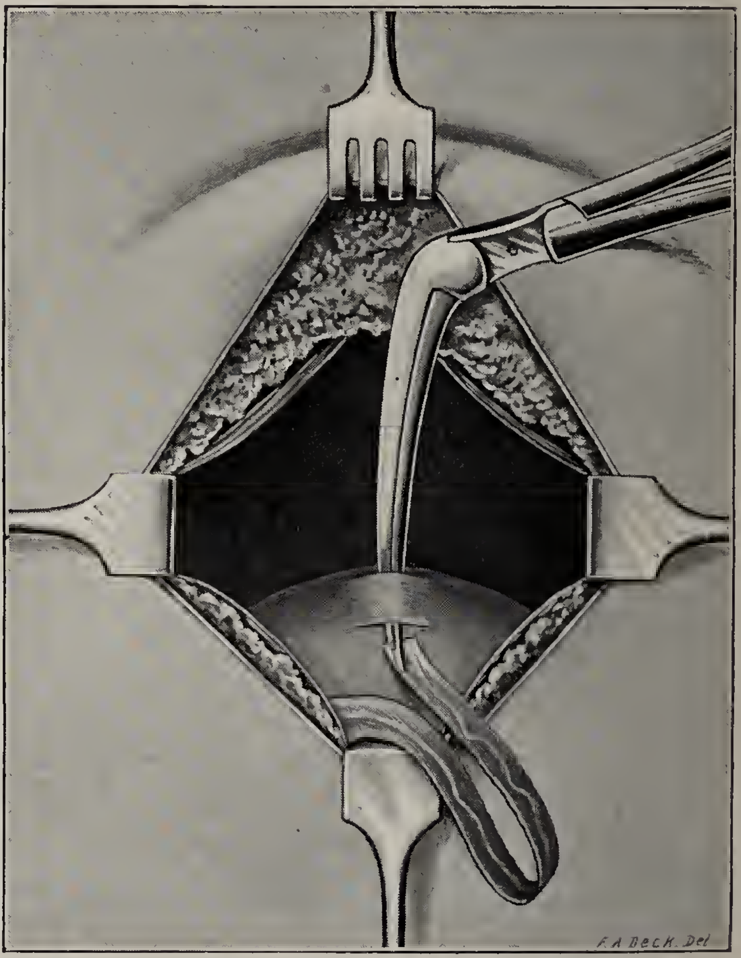

FIG. 664.—SUSPENSION OF THE UTERUS.

Showing the urachus together with a strip of peritoneum dissected loose. The space intervening between two transverse incisions on the posterior uterine wall is raised, a ligature carrier passed and made to grasp the loosened urachus. The latter is then drawn through.

Indirect fixation through the medium of the stump of a removed ovary (Köberle) or **indirect suspension** by transplanting the round ligament and attaching the latter to the abdominal wall (Ferguson) may give satisfactory results. In the last named the round ligaments are drawn into an incision through the transversalis fascia and peritoneum, made on each side of the median line and through the recti muscles. The ligament is grasped by forceps near the internal ring, a ligature applied on each side of the latter and the ligament divided between the ligatures. The distal divided end is dropped into the peritoneal cavity and the proximal end, together with more or less of its attached broad ligament, is sutured to the edges of the opening in the transversalis fascia and peritoneum. A similar procedure is now carried out on the opposite side.

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* "The New York Medical Journal," October 5, 1895.

† "American Medicine," Jan. 11, 1902.

Prolapsus Uteri.—This is preceded in the majority of cases by combined retroversion and retroflexion (Küstner). The prolapse itself is caused by intra-abdominal pressure. Other causes are extensive lacerations of the perineum, a prolapse of the vaginal wall resulting; this in turn, by traction on the uterus, produces prolapse of the latter. Both the round and the uterosacral ligaments are relaxed. Atrophic senile changes and increased abdominal pressure from the presence of tumors or accumulations of fluid in the abdomen may also cause prolapsus uteri. It is usually combined with cystocele; less frequently with rectocele.

The most important **pathologic changes** are thickening of the mucous membrane of the vagina, destruction of the epithelium about the external os and consequent ulceration, enlargement of the uterus due to circulatory disturbances, and in some cases endometritis. In cases of extreme prolapse the bladder usually suffers as well, and cystitis, either simple catarrhal or involving the muscular coat, may occur.

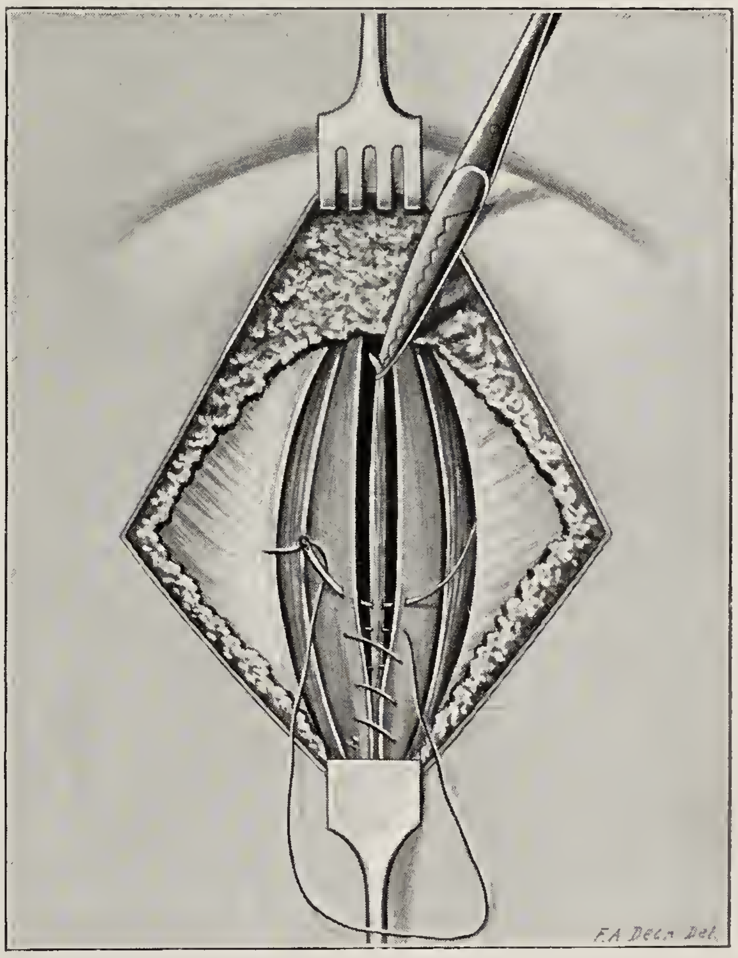

Fig. 665.—Suspension of the Uterus.

The uterus is suspended on the urachus; the latter is replaced and secured by the suture that closes the peritoneum.

Symptoms.—These are so slight at first as to fail to attract attention. Pain in the loins is the first symptom noticed; this increases with aggravation of the prolapse, until finally the patient becomes conscious of a sagging mass in the vagina and attempts to relieve the distress arising from this by pushing it up with the finger. Both vesical and rectal tenesmus follow further descent of the organ. Finally the latter appears outside the vulva. Examination in the earlier stages of a suspected case should be made with the patient standing.

In the **differential diagnosis** prolapsus uteri may be distinguished from a uterine or vaginal polypus by noting the situation and condition of the cervix, and from inversion of the uterus by the presence of the fundus in its normal relations, as shown by bimanual examination.

The **treatment** consists in medicinal measures to overcome the accompanying constipation, which, unless relieved, tends greatly to aggravate the symptoms. Small doses of salines after meals are useful for this purpose. Treatment by pessaries is, as a rule, very unsatisfactory. A pessary that will afford the proper amount of support in the later stages, particularly if it is of the hard-rubber ring or inflated soft-rubber variety, can give only temporary relief, and that at the expense of what little tonicity yet remains of the lateral vaginal walls and pelvic floor, the former being distended laterally and the latter subject to the presence of the pessary with the weight of the uterus added. In the early stages, however, the retroversion pessary of Thomas may be useful.

The **surgical treatment** should be directed toward the return of the uterus to its normal position. The downward traction exercised by the anterior and posterior vaginal walls is to be corrected by the operations of anterior and posterior colporrhaphy and perineorrhaphy, and the weight of the uterus taken off these structures by the shortening of the round and uterosacral ligaments in the early stages, and by ventral suspension in the later stages. In either case the uterus must be placed in the anteverted position. The latter is essential in order more effectually to counteract the tendency to recurrence, the first step of which consists, as in the original displacement, of a retroversion. In old subjects, where the uterus is greatly enlarged and entirely extruded from the vulva (**procidentia uteri**), hysterectomy may be resorted to. This procedure should be applied only in extreme cases, and, except in old and weak subjects, may well be preceded by the foregoing and less radical measures. It should always be followed by immediate anterior and posterior colporrhaphy and perineorrhaphy. In this class of cases, in spite of the radical operation, a hernia of the vagina may develop in the course of time, when ventral suspension of the bladder (Dickinson) may be resorted to.

Inversion of the Uterus.—This term implies a literal turning inside out of the organ. The fundus is invaginated into or through the cavity of the uterus. While usually an accident of parturition, it is not necessarily so. Undue traction on the cord in cases of implantation of the placenta at the fundus and efforts on the part of the uterus to expel the placenta when the latter is at the fundus are the causes usually assigned. In nonparturient cases inversion may be induced by a large pediculated polypus attached to the fundus producing direct traction; or by the presence of small sessile fibromas in the uterine wall, the area occupied by such an intramural growth as well as the surrounding parts becoming weakened and yielding to intra-abdominal pressure. The attempt of the normal uterine wall to expel the incurved or indented portion, coupled with intra-abdominal pressure and progressive paralysis of the zone of uterine tissue surrounding the indented portion as this progresses inward toward the uterine cavity, finally results in inversion (Treub). The cervix is rarely inverted and even inversion of the body may be incomplete.

The **symptoms** in the acute or puerperal cases consist of profuse hemorrhage following the delivery of the placenta. In the chronic or nonparturient cases the symptoms are quite similar to those of prolapsus uteri, with the addition of frequent, though slight, discharge of blood-stained fluid from the vagina.

The **diagnosis** in puerperal cases depends on the demonstrated absence of the fundus above the pubes, conjoined with the presence of a distinct ring at this point and of a globular mass felt in the vagina. In chronic or nonpuerperal cases the finger traces the mass in the vagina to the point of its disappearance through the os uteri. The speculum may show the openings of the Fallopian tubes on the mass. In cases of doubt the absence of the fundus in its normal position may be demonstrated by a sound passed into the bladder meeting a finger passed into the rectum above the presenting tumor.

The **prognosis** of acute parturient inversion is unfavorable. Death may occur very shortly or within a month after the accident. Hemorrhage usually ceases in cases which survive the first month, only to recur when menstruation returns.

The **treatment of acute cases** consists in immediate reposition by means of the fingers of the right hand pressed against the fundus, the left hand steadying the cervical portion through the abdominal wall. If this fails, and the hemorrhage is alarming, a constricting band should be placed around the mass high up, only sufficiently tight to arrest the hemorrhage, and this should be removed after a few hours and attempts at reduction renewed. Various repositors have been devised.

In the **treatment of chronic cases** also the latter have been employed. Hydrostatic pressure by means of an india-rubber bag placed in the vagina, distention of the latter with dilatation of the cervical portion occurring simultaneously with reposition from the pressure of the colpeurynter, has also been recommended (Braun).

In otherwise irreducible cases access is to be gained to the cervix through an incision in the anterior uterine wall and the inverted canal forcibly dilated to an extent to permit reduction. The incision is then sutured with catgut and reposition effected. Or the posterior cervical wall may be incised, the incision in the posterior lip being closed by sutures after the inversion is reduced (Hirst). In my own experience more or less of the posterior uterine wall is included in this incision. The more radical procedures of **amputation of the presenting portion** following the preliminary application of a constrictor, and **vaginal hysterectomy** should be reserved for cases otherwise irremediable, particularly child-bearing women.

THE FALLOPIAN TUBES

In view of the infrequent occurrence of neoplasms, and the still greater rarity of malformations of the Fallopian tubes, practically all the diseased conditions of these structures are due to infection. The gonococcus of Neisser is by far the most frequent cause of these infections, though other pathogenic bacteria are found, either with the gonococcus (mixed infection), which is singularly rare except where adhesions to the intestines exist, or, with equal infrequency, alone. The avenue of primary infection is either the communication between the uterine cavity and that of the tube, an extension of a bacterial endometritis taking place, or the tube, which may be invaded by the tubercle bacillus from a tuberculous peritonitis.

Salpingitis.—The inflammatory condition, except in the mildest cases, is not confined to the tube, other tissues becoming infected either coincidentally or consecutively. This constitutes the condition variously termed **pelvic peritonitis, pelvic inflammation,** etc. The catarrhal and suppurative forms are recognized.

Acute Catarrhal Salpingitis (Endosalpingitis).—The mucosa and submucosa of the tube are the parts primarily affected; in these all the characteristics of inflammation enter. The normal secretion is increased in quantity; otherwise it may be but slightly changed at first, but later on undergoes such changes as may be induced by the ultimate course of the disease. Or it may be purulent from the beginning. With the extension of the infective process round-celled infiltration of the stroma occurs. Resolution may take place in this stage; otherwise the inflammation becomes chronic.

Chronic Salpingitis.—Here the process extends to the muscular portions of the tube. Increase in the length and thickness of the tube tends to produce kinks and twists, the mesosalpinx maintaining its normal relations to the tube. The angles of these distortions become adherent through the medium of deposits of plastic lymph, which become organized; adhesions also take place between the tubes and the neighboring viscera. The ostium abdominale of the tube becomes occluded through invagination and incarceration of the fimbriae, and the retention of secretion thereby produced results, according to the nature of the secretion, in (1) hydrosalpinx; (2) hematosalpinx; (3) pyosalpinx.

Hydrosalpinx is a collection of serous fluid within the Fallopian tube, due to obstruction at some point in the tube. The point of obstruction is usually situated at the fimbriated extremity and is due to adhesions of the serous surfaces of the fimbriae occurring in connection with a pelvic peritonitis. The infecting agent is usually the streptococcus or the staphylococcus; the gonococcus is rarely found. Hence the condition is more frequently of puerperal than of venereal origin. The mildness of the symptoms following invasion is due to a modified virulence of the infecting organisms, the latter giving rise to a simple catarrhal salpingitis only.

Hydrosalpinx may be unilateral or bilateral. It forms a characteristic sausage-shaped tumor, which, though usually of but moderate size, may be sufficiently large to be mistaken for a tubo-ovarian, an ovarian, or a parovarian cyst. The secretion may be clear and watery or slightly tinged with yellowish-green; it is sometimes blood-stained. The fluid is prevented from emptying itself into the uterus by the sphincterlike action of the cornua, by adhesions, pressure occlusion, and torsion and kinks at the uterine end of the tube. In rare instances these are overcome and there is an intermittent discharge into the uterus. In the variety known as **tubo-ovarian cyst** the hydrosalpinx is associated with a cyst of the ovary, the two cavities intercommunicating.

Hematosalpinx is an accumulation of blood within a tube the seat of an occlusion. It may be due to a hemorrhage into a hydrosalpinx, torsions or kinks of the tube causing thrombostasis of the tubal veins. Reflux of menstrual fluid through erratic uterine contractions and vicarious menstruation have been assigned as causes.

Pyosalpinx.—This is one of the sequels of salpingitis, in which suppurative changes take place, and, as a result of occlusion of the abdominal extremity of the tube, a purulent collection occurs within the latter. In the commencement the walls of the tube are enormously thickened and the amount of pus present is small. In the further progress of the case, however, as the fluid accumulates, the walls become greatly attenuated until rupture may take place. The tumor rarely reaches a large size, however. In advanced cases extension of infection to the peritoneum occurs (**perisalpingitis**) and more or less extensive and dense adhesions form, which bind the tube and ovary together, and the mass thus formed in turn to the surrounding organs. Multiple suppurating foci often form in the adhesions (parasalpingeal abscess). The contents of a pyosalpinx vary from a thin seropurulent fluid, containing flocculent matter, to a thick cheesy material. The results of examination of smear preparations, as well as bacteriologic tests, are negative.

In differentiating a pyosalpinx from a hydrosalpinx the following points should be borne in mind: in hydrosalpinx septic fever is absent; whatever constitutional disturbance is present is comparatively slight and pain is almost wanting. The tumor is but slightly fixed, if at all; the adhesions are fewer and the walls of the distended tube are smooth, elastic, thin, and fluctuating. Rupture of the tube is followed by no important sequels. A slight discharge from a catarrhal endometritis is present. In pyosalpinx systemic infection is often marked, septic fever is present, and pain is pronounced. The mass is fixed by adhesions and is hard and nodular; fluctuation is less pronounced. Rupture, if it occurs into the general peritoneal cavity, causes dangerous peritonitis. A purulent leukorrheal discharge from bacterial endometritis is generally present (Dudley).

Symptoms of Salpingitis.—The symptoms of salpingitis relate largely to the involvement of contiguous structures, particularly the pelvic peritoneum, rather than to the tube itself, and depend for their severity on the virulence of the infection and the extent of the accompanying pelvic inflammation. In mild infections occurring primarily in the tube there may be rapid sealing of the fimbriated extremity and consequently but slight pelvic peritonitis. The symptoms may be so slight as not to attract the patient's attention to the diseased part. In more severe cases there will be varying degrees of local distress, these being aggravated by the erect position, motion, the act of defecation, digital examinations, and sexual intercourse. An extension of inflammation to the ovarian peritoneum with resulting formation of adhesions is marked by an increase in the intensity of the pain, which is greatly aggravated at the menstrual period. With increase of the accumulation within the tube symptoms due to mechanic pressure are added, such as painful defecation and micturition, and pelvic tenesmus when in the upright position. Dysmenorrhea is the rule. Menorrhagia is not uncommon, except in tuberculous cases, when the menstruation may be scanty. Leukorrhea arising from septic endometritis is usually present.

The Diagnosis of Salpingitis.—A preliminary digital vaginal examination will frequently serve for a provisional diagnosis. Many cases of inflammation of the adnexa and coincident pelvic peritonitis require, for their differentiation from the other conditions, that the examination be made under a general anesthetic. This insures the necessary relaxation of the abdominal walls without the use of force, the latter an element of danger in itself, and saves the patient the pain almost necessarily incident to the conjoined manipulation when properly performed.

The bowels and bladder being emptied beforehand, and the patient placed in the lithotomy position, the examination is conducted with the index-finger of one hand in the vagina, the other hand being placed on the hypogastrium to steady the parts and to make counterpressure. The position of the fundus is first ascertained, if possible, and then each fornix examined in turn; finally, the finger sweeps across the posterior cul-de-sac. In diseased adnexa a mass can usually be made out on one or both sides, attached to the uterus or fixed with it and representing the diseased tube and other implicated structures.

The **differential diagnosis** must comprise consideration of the following: (1) neoplasms, including those of the intestine and bony pelvic walls; (2) appendicitis; (3) extrauterine pregnancy; (4) fecal impactions; (5) uterine displacements. Of the neoplasms, those springing from the uterus, particularly myomas, being the most common and subject to irregular development, are the most important. There will be an absence of a history of the symptoms of inflammation, pressure symptoms will be more pronounced, menorrhagia more marked, and the development more gradual. Finally, the tumor can generally be traced to the uterus. The two conditions may coexist. Neoplasms of the tubes and broad ligaments are rarely sources of error, except possibly in the case of intraligamentous (parovarian) cysts. Appendicitis may be excluded by the history and the location of the pain and tenderness, as well as the absence, as a rule, of muscular rigidity. Cases of extrauterine pregnancy give a distinctly characteristic history. One tube, however, may be the seat of an ectopic gestation and the other of a salpingitis. Fecal accumulations are usually easily distinguishable with the examining finger. Uterine displacements can generally be made out by conjoined manipulation and, as a last resort, by the use of the sound.

The clinical importance of the differentiation of individual infections is limited practically to the disease as it originates in the gonococcus on the one hand, and the ordinary pus organisms (chiefly the streptococcus) on the other. In gonococcus infection the history may point to the origin of the infection. The onset is more gradual, the pain is more distinctly localized, peritonitis is absent, the general system but slightly affected, and the attack of shorter duration. The patient appears to be in fairly good health. In streptococcus infection the history of a gonorrheal origin is negative. The patient has either been recently delivered or has aborted, or has been subjected to local treatment. The onset is more abrupt and severe, the pain generalized from peritoneal involvement, septic fever is present, and the attack extends over a period of weeks rather than of days as in gonorrheal infection, the patient's general health suffering in consequence. Finally, in gonococcus infection the microorganism may usually be identified in the secretions from the cervix, urethra, or vulvovaginal gland (Kelly).

In **tuberculous salpingitis** the infection may be either primary within the tube, or secondary to tuberculous foci elsewhere. The primary form is an ascending infection from the vagina, usually without involvement of intermediate structures. Descending infection is always secondary and usually arises from tuberculosis of the peritoneum. In the ascending type the germ may be transferred by the spermatozoa or it may enter by the lymphatics after abrasions of the mucous membrane of the genital tract (Hegar). In the descending form, by far the most common, the infection almost always takes place from the peritoneum through the ostium abdominale, either from the entrance of free tubercle bacilli or from the extension of a tuberculous peritonitis. An adherent tube may become infected from an intestinal or a mesenteric glandular tuberculous lesion. Finally, the blood-current may carry the infection, either directly through an infected embolus from a lung or bone affection, or by means of free tubercle bacilli without the presence of any previous tuberculous lesion. A previously existing gonorrheal infection of the tube predisposes to tuberculous infection.

The **symptoms** vary according to the extent of the infection, and, unless a coexisting tuberculous peritonitis or the presence of the tubercle bacilli in scrapings from the uterus points to the origin of the disease, a positive differentiation from other forms of salpingitis is impossible. The prognosis after removal, however, is favorable.

Bacillus coli communis infection may take place as an ascending infection, or through intestinal adhesions arising in connection with appendicitis and other intestinal lesions.

The Treatment of Salpingitis.—Acute catarrhal salpingitis, as a rule, tends to recovery and the purulent form may follow the same course. Sterility, however, is liable to follow when extensive infiltration of the muscular layers has taken place. Ordinary pyogenic infection exerts its worst effects at first; on the other hand, the gonococcus infection, while severe in its manifestations at the outset, is much more persistent and is liable to cause recurrence of the disease.

Acute salpingitis is to be treated with the view of meeting an existing or impending acute localized peritonitis. Rest in the recumbent position, the free use of the vaginal douche, attention to the bowels by the use of calomel followed by salines, the use of ice-bags, or hot stupes if more agreeable to the patient, and of suppositories to relieve pain, are proper measures to employ. In the large proportion of cases improvement will follow the use of these. The general condition of the patient after the subsidence of the acute symptoms will require the use of ferruginous tonics and attention to the general health, and the local conditions (hyperplasia and inflammatory exudates) will demand topical treatment. In a certain proportion of cases surgical intervention alone will save the patient from the life of misery ensuing on an attack of salpingitis.

Local treatment may be instituted as soon as the chronic conditions are manifest. Medicated vaginal tampons of pure glycerin, or of 10 per cent boroglycerid, or of ichthyol in glycerin, are most useful. These should be inserted with the patient in the knee-chest position and a perineal retractor introduced. The applications are to be repeated every two or three days, the patient removing the tampon on the morning of the day of the reapplication and using a vaginal hot douche. Prior to each application **massage** of the thickened and adherent structures by gentle movements of conjoined manipulation is sometimes useful, provided it does not produce pain.

Drainage.—This is efficient both in emptying collections within the tube and in relieving septic conditions in the neighborhood, pending the later and relatively safe application of more radical measures. Whenever any considerable collection of pus can be identified, it should be evacuated, and when such is suspected an exploratory vaginal section should be made. With the patient in the lithotomy position, the weighted speculum introduced, and the posterior fornix exposed, the tenaculum forceps grasp a fold of the vaginal mucous membrane at its junction with the cervix. This is snipped transversely with the scissors, the submucous connective tissue separated with the finger, and the pelvis further explored. Using the finger as a guide and following the curve of the posterior uterine wall to avoid the rectum, the operator works a pair of semiblunt scissors into the mass until the pus cavity is reached. The opening is further dilated, the cavity carefully irrigated with Thiersch's solution, followed by 3 per cent hydrogen dioxid solution (H_2O_2), and a self-retaining tube of soft-rubber is introduced (Fig. 659). The distal extremity of the tube terminates in a copious gauze dressing at the vulva.

In rare instances the situation of the abscess cavity may demand an inguinal or a combined inguinal and vaginal incision. If either of these fail, an exploratory abdominal section will be required.

Salpingectomy.—In the great majority of cases of diseased Fallopian tubes only a removal of these structures will suffice for an ultimate cure. With the patient in the Trendelenburg position a short median incision is made, the intestines carefully held back by laparotomy pads of gauze, wetted, in the presence of pus, with a 1 : 2000 solution of sublimate. In releasing the adherent mass normal lines of cleavage are followed with the separating finger and the tube and ovary finally lifted into the abdominal wound. The edges of the latter are protected against infection by sublimate gauze. The operator may now clamp the ovarian artery and cut away the mass, grasping other vessels as they appear, and, after separate ligation, sew together the peritoneal edges; or he may transfix and ligate the pedicle, cutting the mass away distad to the ligature and treating the stump as in salpingo-oophorectomy (see page 394). If pus is present, the parts should be thoroughly cleansed with hydrogen dioxid followed by saline solution, and a counter-opening made in the posterior cul-de-sac from below by means of the combined puncturing dilator and grasping forceps (Fig. 666), with the finger above at the site of the cul-de-sac as a guide to avoid injuring the rectum. The jaws are separated to dilate the opening, and then closed on a drainage-tube or gauze strip, which is drawn in position from above as the instrument is withdrawn from below. If there is much oozing from the separated adhesions, it may be necessary to pack the cavity with gauze, the end of the strip being led out of the lower angle of the abdominal wound.

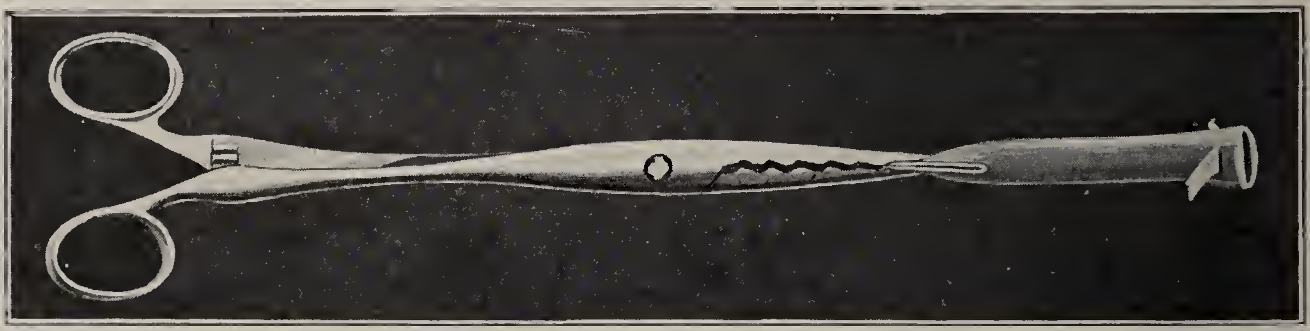

Fig. 666.—Combined Perforator and Clamp for Opening the Posterior Cul-de-sac and Introducing a Drainage-tube from the Abdominal Cavity into the Vagina.
The illustration shows the tube trimmed to a point at its lower extremity and grasped by the instrument ready for placing in position on the withdrawal of the latter.

In cases of streptococcus infection, and even in some cases of gonorrheal infection, the uterus has likewise become the seat of hyperplastic changes which demand its complete removal together with the diseased adnexa, in order to effect a permanent cure. This should be done by the abdominal rather than by the vaginal route.

Tumors of the Fallopian Tubes.—The Fallopian tubes contain the same histologic elements as the uterus, and are therefore liable to be the seat of the same new growths. Those of a benign character are (1) papillomas; (2) cystomas; (3) fibromas.

Papillomas.—These spring from the adenomatous tissue of the glands contained in the mucous membrane of the tube (Bland Sutton). The papillae consist of funguslike excrescences springing from the internal surface of the cyst wall. These vary in size, the larger projections containing daughter cysts (Clark).

The patient's attention is first attracted by the presence of a tumor. This usually appears as a smooth, globular, elastic, fluctuating, and more or less mobile mass. The growth may be so small as to be recognized with difficulty or sufficiently large to effect lateral displacement of the uterus. The development of the growth, as a rule, gives rise to no subjective symptoms other than those of intrapelvic tumors in general; exceptionally, the tumor may be the seat of some pain.

The fact that these growths are liable to rupture and set up general peritonitis, and the additional fact that all papillomatous growths tend to undergo malignant degeneration, render them a constant menace to the life of the patient and emphasize the necessity, as in the case of all pelvic tumors of uncertain character, of their early removal.

Cystomas of the Fallopian tubes are retention cysts of the mucous follicles and result from inflammation and occlusion of the latter. They usually develop from the vestibular mucosa.

Fibromas develop from the muscularis of the tube, are usually small in size, and are either subserous or pediculated; rarely they are interstitial. As a rule, they give rise to no symptoms.

The malignant neoplasms of the Fallopian tubes are (1) carcinomas; (2) sarcomas. **Carcinomas** rarely attack the tube primarily. They are usually a direct extension from either the endometrium, or, less frequently, the ovary. **Sarcomas** occur with less frequency than carcinomas. They are not to be distinguished clinically from the latter, and, like all intrapelvic growths of undetermined character, they should be extirpated early.

THE BROAD LIGAMENTS

Pelvic abscess having its origin in the broad ligament is due to infection by means of (1) the streptococcus; (2) the common colon bacillus; (3) the **Bacillus aerogenes capsulatus.** These gain entrance in the same manner as in ovarian abscess (see page 392). Multiple foci of infection may be present or the abscess cavity may arise from a single focus. The abscess may extend between the layers of the broad ligament and form a tumor beneath both the anterior and the posterior fold of the peritoneum.

The **treatment** is by incision and drainage. The choice of method of operation will depend on the direction in which the abscess presents itself the most prominently. Cases in which the suppurative collection pushes up the anterior fold of the broad ligament will require the extraperitoneal inguinal incision made parallel to Poupart's ligament. The dissection is carried down to the peritoneum and the latter lifted in an upward direction. If the fluctuation can be detected from the vagina, incision and drainage from that direction are indicated. If the suppuration has extended behind the rectum, an incision should be made in the coccygeal region. If the abscess tends to point alongside of the vulva, an incision in this situation should be made; and if pointing on both sides occurs, bilateral incisions connected by a transverse perineal incision are to be made.

TUMORS OF THE BROAD LIGAMENTS

These may be either benign or malignant. Those of benign character may be grouped as follows: (1) cysts; (2) fibromas; (3) myomas; (4) fibromyomas; (5) lipomas; (6) dermoids. The malignant new growths are carcinomas and sarcomas.

Cysts.—These arise principally from the inner tubules of the parovarium as the result of cystic degeneration, and are necessarily intraligamentous. The ovary may remain normal or it may undergo atrophy; it sometimes becomes a part of the tumor. The cyst may grow in the direction of the peritoneal cavity as a smooth tumor of symmetric outline and become more or less pediculated. Or it may grow in the direction of the pelvic floor, and, spreading about the layers of the ligament, appear as a subserous tumor dissecting up the peritoneum. The anterior peritoneal layer may be invaded. As the tumor meets with varying degrees of resistance in its progress behind the peritoneum its outline becomes more or less irregular. The Fallopian tube with its fimbriated extremity is spread out over the surface of the tumor. The wall of the cysts consists of glandular connective and muscular tissue, with a more or less complete investment of peritoneum. In the smaller and more recent tumors the fluid contents are usually clear and limpid, with absence of albumin. In the older and larger growths the fluid is darker in color, thicker, and contains albumin.

Symptoms.—Pediculated cysts of small size rarely give rise to pain or even discomfort. When the cyst is wholly or in part subserous, more or less pelvic discomfort arises from the displacement of viscera. The bladder and rectum are disturbed in their functions, frequent and painful micturition or even incontinence, and rectal tenesmus resulting. Rupture, followed by diuresis, with subsidence of the symptoms, sometimes occurs.

In the **diagnosis** of intraligamentous cysts the pediculated forms with their well-marked fluctuation and smooth contour are liable to be mistaken for hydrosalpinx. The large subserous growths are very liable to be mistaken for ascites. Exploratory puncture should never be employed in the diagnosis.

Treatment.—This is always operative, and should, whenever possible, embrace the enucleation of the cyst wall. In pediculated growths this is comparatively easy. In the subserous varieties, while some of these shell out with ease, in others the procedure may become one of the most difficult in abdominal surgery. In some instances it may be necessary to abandon attempts at enucleation, and, after removing a portion of the cyst wall, stitch the edges to the abdominal wall. The cyst cavity is then packed and drained. Recovery usually follows. Supravaginal hysterectomy is sometimes found to be the easiest and safest procedure in the extirpation of intraligamentous cysts.

Hydrocele of the Round Ligament.—This is analogous to hydrocele of the spermatic cord in the male. The serous accumulation is confined to the canal of Nuck and appears as a fluctuating tumor at the internal ring, in some instances occupying the site of an inguinal hernia and simulating the latter. The treatment consists of incision along the canal the length of the tumor, isolation, ligation, and removal of the sac, and suture of the canal in layers, as in the operation for radical cure of inguinal hernia.

Solid tumors of the broad ligament (**fibromas, myomas, and lipomas**), like intraligamentous cysts, may, though rarely, become pediculated and extend into the peritoneal cavity. In the great majority of cases, however, they separate the folds of the broad ligament and develop in the subserous connective tissue, both anteriorly and posteriorly, completely filling the pelvic cavity, displacing the uterus laterally, forcing the pelvic viscera upward and producing pressure symptoms referable to the bladder and rectum. The diagnosis is not usually made until the abdomen is opened. The only **treatment** applicable is to remove the tumor by enucleation, for which the vaginal route should be invariably chosen. Attempts at **vaginal morcellement** by Pean's method are to be condemned. The removal of the pediculated variety offers no special difficulty. The raw surfaces of the interior of the cavity left by shelling out the tumor are simply covered by the peritoneal folds, a portion of which formed the serous investment of the growth; no suturing is necessary. Drainage is superfluous. On the other hand, the removal of the subserous variety may, in certain cases, present almost insurmountable difficulties, owing to troublesome hemorrhage and the dangers of injuring important structures, particularly the ureters, bladder, and iliac vessels. In these difficult cases the uterus may have to be sacrificed by resorting to supravaginal hysterectomy as an aid to the removal.

Dermoids occupying the broad ligament develop in the retroperitoneal connective tissue. As a rule, only pressure symptoms are present. The direction in which the growth presents itself the most prominently will determine the route for its removal. Those lying in front of the rectum are best attacked from the perineum, while those presenting posteriorly are more easily reached by incision along the coccyx and sacrum. Either of these may require in addition a suprapubic extraperitoneal incision before the enucleation can be successfully accomplished.

Solid tumors of the round ligament are uncommon. When they spring from the outer extremity of the ligament, they develop beneath the parietal peritoneum (properitoneal tumors) and may occupy the inguinal canal. Others develop within the peritoneal cavity and become intrapelvic. The first named are easily reached by an incision similar to that employed for the radical cure of inguinal hernia (see page 176). In the second the operation is similar to ovariotomy (see page 399).

Varicocele of the broad ligament, or dilatation of the veins of the ovarian pampiniform plexus, is met with occasionally in the course of abdominal operation. Thrombi, with subsequent calcareous degeneration and the formation of phleboliths, have been observed. Arrest of involution of the vessels following confinement, diseased conditions of the veins, relaxation of the tissues in debilitated subjects, the length of the ovarian veins and the consequent weight of the column of contained blood, habitual constipation, and uterine displacements, have all been ascribed as causes. As in the case of varicocele in the male, the left side is more frequently affected than the right, and the same cause for this is assigned, namely, obstruction caused by the anatomic relations of the spermatic and ovarian vessels as they empty into the renal vein (Dudley).

The **symptoms** are dull aching pain when the patient is standing, which is relieved by rest in the recumbent position. Frequent menstruation, menorrhagia, or post-climacteric metrorrhagia may be present. The preoperative diagnosis is uncertain. When the affection is complicated by other diseased conditions of the adnexa, the removal of the latter by the method of mass-ligation usually cures the condition. If existing alone, the dilated veins may be tied off in sections and divided between the ligatures (Reed).

Aneurismal varix arises from the increased number and enlargement of the blood-vessels in the broad ligament. The symptoms and treatment are the same as in varicocele (*vide supra*).

Malignant neoplasms of the broad ligaments are generally secondary growths from primary deposits in the uterus, vagina, ovary, or peritoneum. Their operative treatment depends on the extent of the primary disease, as well as on that of ligamentary and other secondary deposits.

THE OVARIES

Inflammations of the Ovaries.—These are due almost invariably to bacterial infection. **Hyperemia** and subsequent changes practically identical with inflammatory conditions sometimes exist, and are caused by malpositions, strangulations from twist of the mesovarium, and irritations arising from undue or unnatural sexual excitement. In **acute oophoritis** the infecting agent is almost always the streptococcus, which finds its way through the lymphatics and blood-vessels in a direct line of transmission from the external genitalia and the mucous membrane of the vagina and uterus. In cases which go on to suppuration minute abscesses fill the stroma and the contents of unruptured follicles become purulent; these may coalesce and cause complete destruction of the stroma itself. In more favorable cases resolution takes place, leaving the ovary indurated, bound down by adhesions, and, in most instances, practically functionless. **Gonococcus infection** of the ovary gives rise to a perioophoritis rather than to a parenchymatous oophoritis, the infection taking place through the progressive invasion of contiguous mucous surfaces. Though a mixed infection is more than likely to be present in gonorrhea, the presence of the gonococcus has not been demonstrated in the pus of an ovarian abscess.

Other agents of infection of the ovary are the Bacillus coli communis and the Micrococcus lanceolatus (rare). In the case of the first named the infection and subsequent abscess are due to adhesions to the bowel resulting from previously existing pelvic inflammation.

Tuberculosis of the ovary is not so rare a disease as was formerly supposed. The infection takes place either (1) through infection transmitted in continuity along the Fallopian tube (Klebs), (2) through an abrasion without a primary tuberculous lesion in the vaginal vault, or (3) through the peritoneum (Schöttlander). Infection rarely takes place through the general circulation. When this does occur, however, miliary tuberculosis is present. In the latter form the symptoms are practically *nil*, while in the caseous form the symptoms are those of pelvic inflammation and abscess. A differential diagnosis is impracticable, though a characteristic feature is said to be the presence of a comparatively insensitive and decidedly enlarged ovary, which is adherent to the uterine wall (Martin, Hegar).

The **treatment** of infections of the ovaries is usually carried on in connection with similar coincident infections of the Fallopian tubes. This may be either palliative or radical. If due to gonococcus infection, the former will generally suffice, since this microorganism, as a rule, is neither long-lived nor virulent when brought in contact with peritoneal surfaces. Here, rest in bed, the administration of saline cathartics and the use of hot vaginal douches and glycerin tampons on alternate days, and ice-bags over the groin, fulfil the immediate indications. In streptococcal as well as in pneumococcal infection, on the other hand, the symptoms are always more or less severe, particularly the constitutional disturbances. These latter, associated with enlargement, tenderness, and fixity of the ovary, indicate the presence of pus and demand surgical interference.

In chronic cases treatment is directed rather to the results of the infection than to its presence. The symptoms of pain and pelvic tenesmus now present depend on hyperemia due to the presence of adhesions, the recurrence of menstruation, indulgence in sexual intercourse, and the existence and increase of unruptured follicles. These should be met by rest in bed, douches, tampons and the relief of the usually coexisting constipation. These palliative measures may be supplemented later on by sea-bathing, or by a course at the iodobromin baths of Salsomaggiore, Italy. Permanent cure will depend, in the majority of cases, on the removal of the diseased organ.

Conservative operative procedures in the case of diseased ovaries is sometimes followed by good results. If, in a given case in which the symptoms relate principally to only moderate pain at or just before the menstrual period, or in which the so-called reflex neuroses are not prominent features, and the ovary presents, on opening the abdomen, but comparatively few unruptured and degenerated follicles with a proportionate amount of healthy stroma, excision of the diseased portion and careful suture of the resulting gap with fine catgut may be made; even the removal of all except the parovarium, the latter being left intact as far as possible, is followed ultimately by good results in a certain proportion of cases. The shock of the operation is less than in complete ablation, the period of convalescence shorter and the subsequent neurotic disturbances comparatively less pronounced, and the prominent symptoms greatly relieved. Nevertheless, in all cases the surgeon should be at pains to explain to the patient that, while the conservative operation permits the persistence of menstruation and the possibility of conception as well as enables her to escape the uncomfortable sequels incident to an artificially produced menopause, on the other hand the cure is not so assured, and therefore another and more radical operation may become necessary in the future.

The **radical treatment** of infections of the ovaries and their results consists in the removal of the diseased organs (oophorectomy). Unless the Fallopian tube, otherwise useless after the removal of the corresponding ovary, can be made to serve some good purpose by remaining, such, for instance, as the suspension of a restored retrodeviated uterus in position (abdominal hysterorrhaphy), it should be removed likewise (salpingo-oophorectomy).

In tuberculous oophoritis extirpation of the diseased organ together with the corresponding Fallopian tube as being the probable avenue of infection and itself diseased and useless, is always indicated. The coexistence of general tuberculous peritonitis is no contraindication to the operation in tuberculous cases, since even exploratory abdominal section is found to be almost constantly followed by recovery from the operation and, in a large proportion of cases, by cure of the disease.

The **technic of the operation** consists in making a median incision 2½ to 3 inches long, introducing two fingers of the left hand and gently separating the adhesions as the fingers are passed from the fundus of the uterus along the tube and ovarian ligament to the ovary, grasping the ovary between the two fingers, and bringing it, together with the tube, out of the abdominal opening. The pedicle is now transfixed as near the uterine cornua as possible, two strands of braided catgut passed, and the pedicle tied in two portions. The mass left after the tube and ovary have been cut away should be of safe size, and, in order to afford further security against hemorrhage in the event of the slipping of the ligature, as well as to reduce as much as possible the raw surfaces of the stump that are liable to become adherent, the latter, in the case of each tube, are turned facing each other and secured by a number of through-and-through sutures, and the peritoneal edges of the stump sutured together.

Tumors of the Ovaries.—Tumors of the ovaries may be either benign or malignant. Cystic neoplasms are by far the most common of the benign neoplasms, while primary carcinoma of the ovary is the most common form of malignant disease of this organ.

Simple Follicular Cysts.—These are primarily dilated follicles and are the result of previous inflammatory changes in the ovary, involving thickening of the fibrous tunic and leading to retention. The smaller cyst formations are known as **hydrops folliculi** (Martin) or **cystic degeneration of the ovary** (Hegar). Follicular cysts develop on the surface of the ovary, are of slow growth, and may vary in size from a slightly diseased follicle to an adult head. A large sized cyst finally replaces the ovary, the latter appearing flattened out on the wall of the cyst at its base. The ovary will usually contain a number of dilated follicles; as a rule, however, but one of these attains a large size. The contents consist of a straw-colored fluid, which is usually clear; it may be turbid from the presence of blood.

Cysts of the corpus luteum develop in the ruptured follicle, and, like the follicular cysts, are of slow growth. They seldom attain so large a size as the latter. Unlike follicular cysts, they are usually solitary. They are formed at one or the other pole of the ovary, their walls are thicker than simple dilated unruptured follicles, and are further to be distinguished from the latter by the yellow or brown color of the inner or lutein layer of the cyst wall. The cyst contains clear serous fluid. The two varieties of cysts may be formed in the same ovary.

Tubo-ovarian cysts or cysts involving both the ovary and the tube are almost without exception of follicular origin, the primary and larger development taking place from the ovary, the tube becoming involved through inflammatory adhesions between the ovary and the tube. They vary in size from a pigeon's egg to a lemon or an orange. They contain a clear serous fluid. The cavity of the cyst may communicate with the cavity of the uterus; the contents may occasionally escape through the exit thus afforded.

Proliferating or neoplastic cysts differ from the foregoing in that they are new formations and not retention cysts. They are designated as glandular or papillary according as they contain papillary growths or not (Waldeyer). They have also been divided on the basis of the chemic constituents of their contents (Pfannenstiel, Hammarsten), the division being made into two groups according to the presence or the absence of a substance resembling mucin (pseudomucin), namely, pseudomucin cysts and serous cysts.

Pseudomucin cysts may attain an enormous size. They are met with more frequently among unmarried and sterile women. They may be simple or monolocular. They are usually spheric or ovoid in shape when made up of a single cyst and irregular in outline when monolocular and large, with smaller cysts developed in the general cyst wall. The cyst contents are usually of the consistency of rather thick mucilage, the fluid being very thick and ropy.

Serous cysts of the proliferating variety are less frequently observed than the foregoing; as a rule, they are much smaller in size, never reaching the enormous proportions of pseudomucin cysts. It is this variety of cyst which is frequently found between the folds of the broad ligament and which tends to form adhesions to adjacent viscera. They usually contain papillary growths; the latter sometimes appear on the outer surface as well as in the interior. The contents consist of a highly albuminous straw-colored or greenish fluid in which pseudomucin in absent. Papillomatous growths are occasionally found on the surface of the ovaries (**superficial papilloma of the ovary**). Cysts with papillary growths are liable to give rise to implantation metastases, both beneath and on the peritoneum. This is likely to take place during operation and lead to recurrence after removal. When situated in the retroperitoneal connective tissue, they rarely contain gelatinous material. Malignant degeneration may occur, both carcinoma and sarcoma arising.

Dermoid Cysts.—These are the least frequent of ovarian cysts. They rarely attain a size larger than an adult head. They are usually pediculated, though they occasionally develop in the folds of the broad ligament. They are usually unilocular and contain a pultaceous fat-like substance, balls of hair, teeth and bones, and caseous masses representing sebaceous matter. The rudimentary prototype of nearly every tissue or organ in the body has been found in dermoid cysts of the ovary. They were formerly believed to have their origin in the inclusion in the ovary of displaced embryonal substance. The present theory of the histogenesis of ovarian dermoids, however, supposes the growth to take its origin in the ovule (Wilms), the latter possessing all the elements necessary for the development of the tissues and structures of the human organism.

Fibromas of the ovary are rare. They are usually smooth and pediculated; occasionally they are intraligamentous. Cysts may be present either from the presence of dilated blood-vessels or lymph-vessels or as the result of degenerative processes. Myxomatous changes may occur or calcareous deposits may be found. Fibromas of the ovary consist of fibrous tissue, and occasionally more or less smooth muscle-fiber is present (**ovarian fibromyomas**). Pure myomas of the ovary are very rare. **Calcified tumors,** as well as **calcareous tumors,** of the ovary have been observed. The former have been mistakenly regarded as osteomas.

Hematoma of the Ovary.—Small hemorrhages may be due to rupture of vessels in the wall of the ovisac (follicular hemorrhage). The term hematoma of the ovary, however, is restricted to a distinct though small tumor varying in size from a hazelnut to a small orange. In the latter case the hemorrhage usually takes place in a follicular cyst. Rupture of the cyst may take place, in which case the symptoms will resemble those of early rupture of an ectopic gestation sac. Hematomas of the ovary are not usually diagnosed until operation.

Malignant Neoplasms of the Ovary.—Of the malignant tumors of the ovary, carcinoma is the most common. This may be secondary to carcinoma of the uterus or other organs, or primary. Primary carcinoma presents itself (1) as medullary carcinoma; (2) as adenocarcinoma.

Medullary carcinomas are either rounded or irregular in outline, vary in size and are of a more or less firm consistence. They are usually pediculated; occasionally they are found partially within the folds of the broad ligament.

Adenocarcinomas consist of cystic tumors, rounded or oval in shape. They are usually attached by a short pedicle, though they may develop within the folds of the ligament; adhesions to the surrounding viscera are common. They rarely attain a size larger than an adult's head. Papillary or cauliflower growths spring from the internal surface of the cysts. The contents of the cysts may be clear, turbid, or blood-stained from hemorrhage into the cyst. Solid masses of carcinoma may be present in the wall of the cyst. Lime salts are sometimes deposited in the papillary growths. Metastases to the peritoneum, to the opposite ovary, to the abdominal viscera, and occasionally to the pleura occur.

Secondary carcinomas most frequently follow carcinomas of the uterus. They may, however, follow carcinomas in almost any portion of the body, particularly in the opposite ovary and in the stomach and breast.

Sarcomas of the ovary may appear at any period of life. The tumors are solid, rounded, have a smooth surface, and may attain a large size (20 pounds and upward). Round-celled sarcomas are soft, while the spindle-celled variety are firm in consistence. They often contain considerable fibrous tissue (fibrosarcomas). Cyst formations are sometimes present as the result of hemorrhage into the tumor substance, or of degenerative changes in the tumor.

Endotheliomas of the ovary occupy a place midway between carcinomas and sarcomas. They have their origin in the endothelium of the blood and lymph-vessels of the organ. They usually occur in middle age; they have been observed in childhood. These growths vary in size from a man's fist to an adult head. They are rounded or lobulated, usually attached by a short pedicle, and are adherent to adjacent structures. Small cysts, and rarely papillary formations within these, have been observed. Hyaline and myxomatous degeneration are prone to occur. Other tumors of the ovary may coexist. The malignancy of endotheliomas is undoubted.

The Symptoms of Ovarian Neoplasms.—With the exception of dermoid growths, pain is not a common symptom of an ovarian tumor. Quite commonly there is not even sufficient discomfort to attract attention until a tumor is accidentally discovered in the lower abdomen. Disturbances of menstruation are not constant. Amenorrhea, when present, may lead to a suspicion of pregnancy. Mechanic pressure in the case of large tumors will cause vesical irritation, constipation, and renal disturbances. Scanty urine and albuminuria are common under these circumstances. Edema of the lower extremities may follow. Hemorrhoids are not uncommon. In carcinoma of the ovary ascites is frequently one of the first symptoms to attract attention.

The Diagnosis of Ovarian Tumors.—Small growths rest within the pelvis and may be felt in the Douglas cul-de-sac, but when they increase in size they rise into the abdominal cavity. Ovarian tumors are usually more or less mobile, the degree of mobility depending on the length and size of the pedicle. The uterus may be displaced laterally or forced into extreme anteversion. Irregular projections on the surface are characteristic of multilocular growths. As the tumor rises from the pelvis the intestines are crowded upward and toward the opposite side, where their characteristic resonant note may be elicited on percussion, while the position occupied by the tumor will be represented by a dull area below.

The Differential Diagnosis of Ovarian Tumors.—Differentiation between the different varieties of nonmalignant neoplasms is frequently impossible. In a general way, it may be said that solid tumors develop more slowly, while proliferating cysts grow with greater rapidity. The efforts of the surgeon will be usually limited, however, to distinguishing between benign and malignant growths. Tumors of markedly rapid growth are more than likely to be malignant, while those of slow growth are likely to be benign. The early appearance of ascites should always excite a suspicion of malignancy. Decided increase in the rate of growth, unaccompanied by acute symptoms, may be due to a change of type from benign to malignant, or to circulatory disturbances the result of pressure of the tumor itself. Sudden increase in size, associated with acute abdominal and pelvic pain and excessive tenderness, and followed by toxemic symptoms, is usually due to torsion of the pedicle.

Large cystomas are to be differentiated from **pregnancy** by the absence of the signs of the latter, though cases of ovarian tumor have been observed in which reflex vomiting, enlargement of the breasts, and softening of the cervix uteri have all been present. A bruit having its origin in the enlarged veins of certain ovarian tumors may simulate the placental bruit.

Tumors of the uterus, particularly fibrocystomas, are to be carefully distinguished from tumors of the ovary. In differentiating uterine and ovarian tumors, **Hegar's test** is employed as follows: The cervix is seized with a volsella-forceps and drawn downward, and the forceps given in charge of an assistant. The surgeon outlines the tumor by placing his right hand in the suprapubic region and passing his left forefinger into the rectum. The tumor is then lifted and the effect of this movement on the forceps noted. If the mass is closely connected with the uterus, a pulling sensation will be conveyed to the hand supporting the forceps or the forceps will be seen to rise. In the case of an ovarian tumor, resistance will not be so immediate nor so pronounced. Further, if gentle traction is made on the forceps while the tumor is thus supported, the pedicle may be felt as a tense band by the finger in the rectum.

In differentiating **ovarian tumors and cysts springing from the mesentery,** as well as **hydronephrosis,** the fact that in the former the upper limit of the growth is free, while in the latter the lower margin of the growth can be outlined, should be borne in mind. The use of the catheter will prevent a **distended bladder** from being mistaken for an ovarian tumor.

Finally, in all cases of abdominal tumor of an obscure character, particularly where the growth exhibits a tendency to increase in size, exploratory incision is not only justified but imperatively demanded.

The Complications of Ovarian Tumors.—Ovarian tumors may occur coincidentally with tumors of the uterus, inflammatory conditions of the adnexa, and lesions of any of the intra-abdominal organs.

Pregnancy is not an uncommon complication of an ovarian tumor. Abortion is likely to follow, or, if the pregnancy goes on to full term, rupture of the cyst may occur during labor. Infection of the cyst followed by inflammatory conditions and the formation of adhesions, may take place at any time. The mortality in cases of pregnancy complicating ovarian neoplasm is high (from 25 per cent to 43 per cent, according to different authorities). The proper **treatment** is to perform abdominal section and remove the tumor. The best interests of both mother and child are conserved by following this course.

Torsion of the pedicle results from rotation of the tumor on its own axis. It occurs in over 9 per cent of the cases (Thornton). The causes of this condition have been variously stated as the descent of masses of fecal matter (Tait), the turning from the back to the side while in the recumbent position (Doran), and blows and sudden strains (Thornton).

Changes in the position of the tumor from pressure from without, such as occur when the patient is working at the washtub, may produce it, as happened in one of my cases. It is said to have occurred from emptying of the uterus when pregnancy was present as a complication. The twist in the pedicle produces mechanic obstruction to the return circulation in the tumor. This is followed by sudden increase in size of the tumor, accompanied by pain due to pressure on the nerves in the pedicle. Hemorrhage takes place into the peritoneal cavity from rupture of the vessels on the surface and into the cavity of the cyst as well. These symptoms are accompanied by shock and later on by general infection. The **treatment** is by operation. This should be carried out as soon as the shock will permit and before pronounced septic conditions are present.

Ascites as a complication of ovarian tumor may be of cardiac, renal, or hepatic origin, these in their turn being due to the pressure of a large ovarian neoplasm. The presence of fluid in the peritoneal cavity may accompany an ovarian tumor of small size, if the latter is malignant. In the **treatment** of ascites as a complication of an ovarian tumor, if the presence of the growth is found to be responsible for the condition, this should be removed at once.

Rupture of an ovarian cystoma may result from degenerative changes, infection of the contents of the sac, overdistention, or traumatism. The symptoms will depend on the size of the sac, the extent of the rupture, and the character of the fluid which escapes into the peritoneal cavity. An extensive rupture of a small sac or a slight rupture of a large sac may give rise to but mild immediate symptoms, and, if the fluid is sterile or unirritating, to but slight after-effects. On the other hand, the sudden pouring out of a large quantity of septic or irritating fluid into the peritoneal cavity will give rise to symptoms of profound shock, and be followed by diffuse septic peritonitis and general infection. Finally, the presence of a small quantity of septic fluid may not give rise to shock but may be followed by diffuse septic peritonitis. The **treatment,** therefore, should be operative. The abdomen should be immediately opened and the tumor removed; the peritoneal cavity should be cleansed, and if necessary drained.

The Treatment of Ovarian Tumors.—This is always surgical. The operation of removal of the tumor (**ovariotomy**) should be undertaken as soon after the diagnosis is established as the patient's condition will permit. A three-inch median abdominal incision is first made and enlarged later on, if the exigencies of the case require it. The nature and extent of any adhesions present are ascertained by two fingers of the left hand swept over the face of the tumor in all directions. The cyst wall is recognized by its pearly gray color. A trocar (Fig. 667) is plunged into the cyst cavity and the contents of the latter drawn off. As the cyst walls collapse, the cyst is drawn out of the wound, every effort being made to prevent the cyst fluid from soiling the edges of the latter, as well as from entering the peritoneal cavity, by pressing the abdominal walls against the tumor and keeping the point where the trocar was introduced well extruded. Multilocular cysts are emptied by passing the trocar in different directions from the original cyst emptied; the hand is passed through the enlarged opening and supports the tumor as the collapsing cyst is forced out of the wound. Recently adherent points may be pressed apart with gauze; old and firm adhesions, particularly those involving omentum, must be ligated in two places and cut between the ligatures. Old and dense adhesions that involve intestine and that are too short to admit of double ligation, are to be dealt with by leaving a portion of the cyst wall attached to the intestine. The pedicle is transfixed by means of a ligature carrier armed with braided catgut (Fig. 658) and each half tied separately. The tumor is now cut away. The raw surfaces of the stump are now brought face to face with each other and sutured in this position. This constitutes a safeguard against oozing from the stump, prevents slipping of the ligature, and minimizes the opportunities for the formation of subsequent intestinal adhesions. If the other ovary is diseased, the affected portion should be removed, a portion of the organ, however small, being retained, if possible. If the patient has suffered from shock during the operation, the abdominal cavity may be filled with the decinormal saline solution for the purpose of auto-infusion. Drainage is rarely necessary.

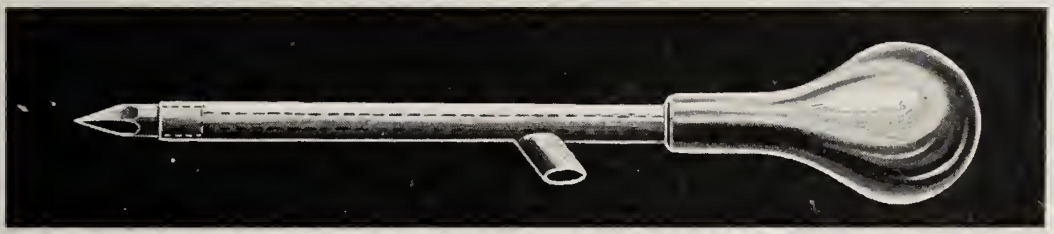

Fig. 667.—Tait's Ovariotomy Trocar.

In closing the abdominal incision, the peritoneum is first secured by a running suture of catgut, after which the remainder of the wound may be closed by the removable layer or figure-of-8 suture (see page 324, Vol. I). Or through-and-through sutures of silkworm-gut, placed about one-fourth of an inch apart, may be employed. The parts about the wound are cleansed with hydrogen dioxid solution, dried, and dressed with sterile gauze held in place by means of strips of adhesive plaster placed laterally and the latter connected by tapes (Fig. 668). In the case of a large tumor the hollow left may be filled with sterilized cotton between the dressings and the binder. The latter should be pinned in "gores" to make even pressure (Fig. 669) or the so-called "many-tailed" binder may be used (Fig. 670).

In the **after-treatment** of ovariotomy hot saline enemas are to be given every three or four hours, or more frequently if expelled. The patient may take frequent sips of hot water or tea as soon as the ether nausea subsides. On the evening of the third day small doses of calomel (one-fourth of a grain every half hour for four doses), followed by sulfate of magnesium, are to be given to secure movements of the bowels.

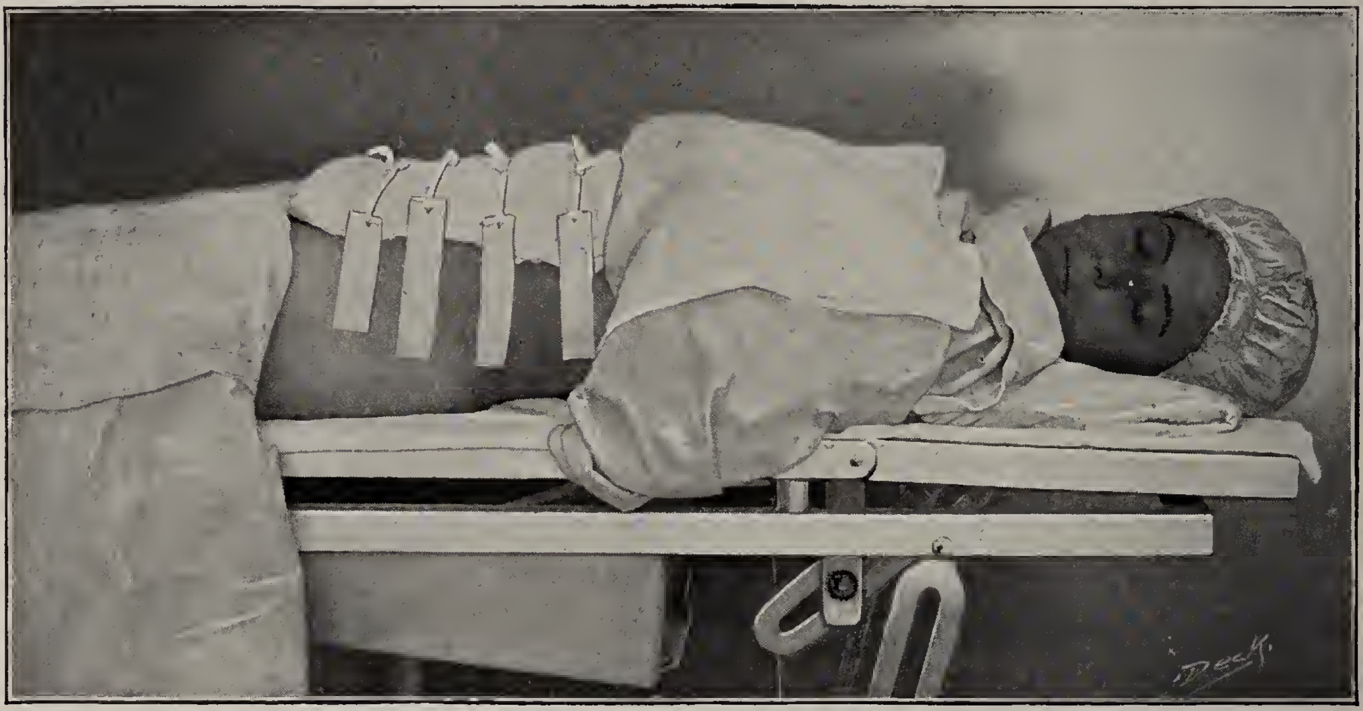

Fig. 668.—First Pieces of Dressing Held in Place by Adhesive Plaster Strips and Tapes.

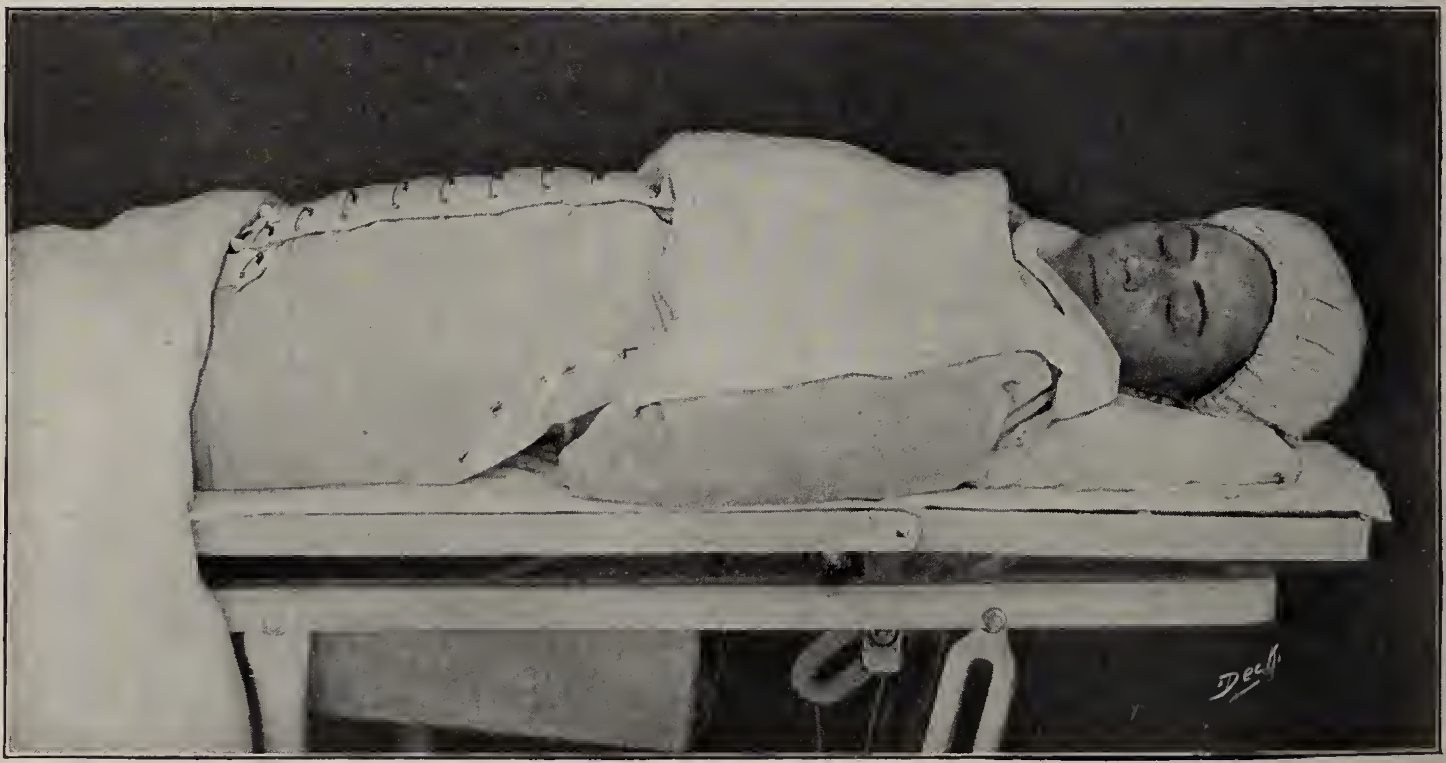

Fig. 669.—The Binder Applied.

An **incomplete ovariotomy** is one in which it becomes necessary, either from the presence of many and extremely dense adhesions involving important structures, from the character of the neoplasm itself, or from the occurrence of shock from hemorrhage and a prolonged operation, to remove only a portion of the cyst wall, the opening in the remainder being stitched into the abdominal incision. The cavity of the cyst is then tamponed with gauze; complete sloughing away of the remaining portion of the tumor sometimes follows.

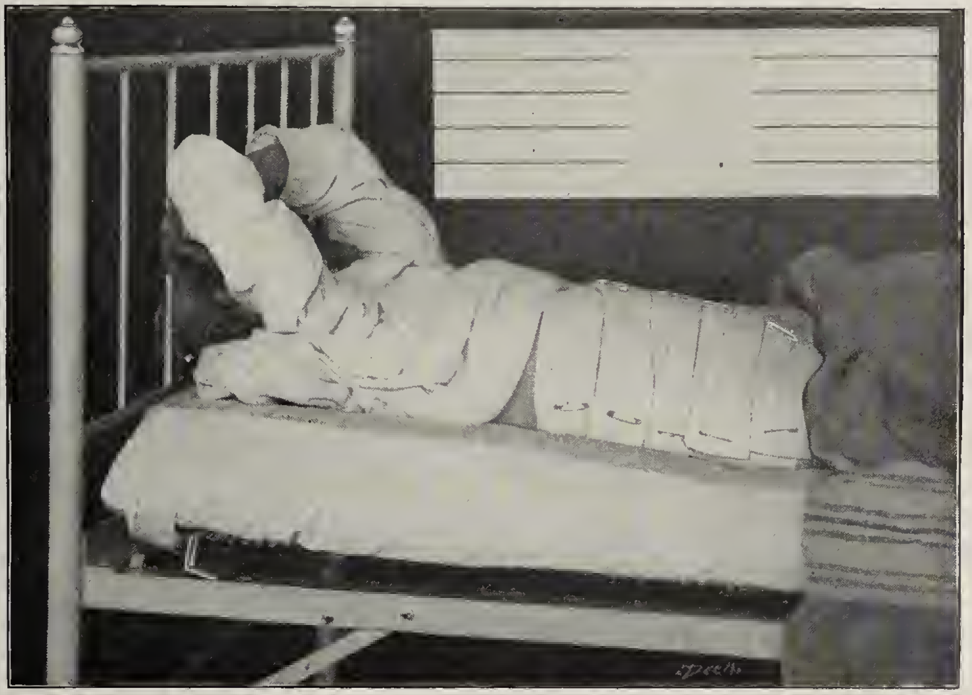

FIG. 670.—THE MANY-TAILED BINDER.
The upper figure represents the shape of the binder before application.

ECTOPIC GESTATION

Ectopic gestation is a fixation and development of an impregnated ovum outside the uterine cavity. All cases of extrauterine pregnancy are primarily tubal. Coincidentally with either rupture or change of situation, or both, the gestation may become either ovarian or abdominal. When the pregnancy develops in the free portion of the tube, it is called **tubal pregnancy**; when in the tube where the latter passes through the wall of the uterus, or in a diverticulum at the uterine end of the tube, **interstitial pregnancy**; and when in the infundibulum of the tube, **infundibular pregnancy. Tubo-ovarian pregnancy** arises when the ovum, in the last-named situation, is attached to the ovary.

Etiology.—The causes of ectopic gestation reside in the ovum itself, pathologic conditions of which, as well as abnormal conditions of the tube, favor its arrest in the lumen of the tube. The latter are the most generally recognized and important, and consist of congenital diverticula, occlusions, and exaggerated convolutions; acquired distortions of the tube from adhesions and pressure; thickening of the walls of the tube, either the result of inflammatory conditions or congenital in origin; endosalpingitis, terminating in destruction of the cilia or stenosis of the canal; and intratubal interstitial growths.

Pathology.—The uterus is enlarged, though it is smaller proportionately than in normal pregnancy. A decidua is formed both in the uterus and in the tube, which is cast off in both cases at the termination of the pregnancy. The tube and ovum undergo swelling and turgescence with increase in the caliber of the vessels, and hypertrophy of the muscular coat, changes similar to those which occur in the uterus during normal pregnancy. The ostium abdominale closes at about the seventh week, except in cases in which the impregnated ovum is retained near the abdominal opening, in which case the former is extruded into the abdominal cavity, constituting a **tubal abortion.** A tubal decidua is formed; the latter is sometimes formed in the other, or nonpregnant, tube as well. A uterine decidua is likewise formed (Langhans, Herzog). When arrest of development of the ovum takes place, the latter is detached, its blood-supply cut off, and a **tubal mole** results. This may either be absorbed or escape into the abdominal cavity through the ostium abdominale or a rupture of the tube. In tubal pregnancy the placenta is disturbed in its development, owing to the inability of the tube wall to accommodate itself to the growing ovum, and hemorrhages take place into the intervillous spaces. Rupture of a gravid Fallopian tube usually takes place prior to the fourth month; the severe hemorrhages occurring in connection with this accident have their origin in the detachment of the placenta.

Symptoms and Diagnosis.—Menstruation is almost always disturbed. It may be retarded or otherwise irregular. The bleeding comes from the endometrium. Part or all of the decidua may be cast off with the flow of blood from the uterus at any time during the course of an ectopic pregnancy. Cessation of menstruation occurs in about one-half the cases. Morning sickness is present to about the same extent as in normal pregnancy. Pelvic pain, periodic in its occurrence, colicky in character, and accompanied by faintness, is present. This is due to contractions of the uterus and pregnant tube, and quite commonly is the first symptom to attract the patient's attention. Rupture of the gestation sac may occur during these pains. A well-defined mass may be felt in one of the fornices or in the posterior cul-de-sac, on digital examination *per vaginam.* Prior to the average time of termination of the gestation by rupture, the objective signs of normal pregnancy if present may be so slightly marked as to be of little value in the diagnosis.

With the four cardinal symptoms present, namely, disturbances of menstruation, sharp colicky pelvic pains usually accompanied by faintness, the presence of a mass connected with the adnexa, to which may be added enlargement of the uterus, the surgeon will be justified in passing the sound to supply the confirmatory evidence of an empty uterus. The presence or absence of a uterine decidua cannot be looked on as of diagnostic importance at the present time. Chorionic villi may come from the tube and be found in the uterus; or a uterine decidua may be cast off at the time of rupture, abortion, or on the death of the embryo from any cause, and hence be absent when sought for.

With the occurrence of **primary intraperitoneal rupture,** which takes place more commonly before the seventh week, the symptoms are those of an acute and sudden abdominal lesion, plus those of severe concealed hemorrhage (**diffuse intra-abdominal hemorrhage**). The abdominal pain is severe and is accompanied or followed by faintness. In some cases the bleeding ceases and then recurs. The rapidity with which death takes place is appalling. The diagnostic points to be relied on in ruptured ectopic gestation are (1) the sudden seizure and collapse; (2) increasing pallor of the surface and gradual increase in the pulse-rate without corresponding rise of temperature; (3) marked tenderness of the abdomen without muscular rigidity of its walls and other signs of peritonitis. The presence of blood in the abdominal cavity can rarely be demonstrated, even when the hemorrhage is enormous.

Primary extraperitoneal rupture is said to have taken place when the gestation sac develops in such a manner as to cleave the folds of the broad ligament, and rupture takes place in the latter situation. The symptoms of pain and faintness are increased in severity and become recurrent and paroxysmal. The collapses are less severe and the signs of hemorrhage less pronounced, owing to the delimitation of the effused blood by the structures of the broad ligament (**hematoma of the broad ligament**), where a protective exudate incloses it in cases in which no further rupture takes place. The mass usually undergoes subsequent septic changes. Or the barrier interposed by the folds of the broad ligament may be insufficient and further rupture take place. The ovum may survive and in its further development cause rupture into the general peritoneal cavity, with the symptoms of intraperitoneal hemorrhage (**secondary rupture**).

Unruptured Tubal Pregnancy.—If the ovum survives beyond the fourth month, the symptoms and signs of pregnancy are more decidedly present. The pregnancy becomes abdominal by reason of thinning and final giving way of its tubular environment, sufficient attachments to the mucous membrane of the tube remaining to nourish the ovum. When term is reached, **false** or **spurious labor** sets in and causes the death of the child, after which the abdominal swelling subsides, involution of the uterus occurs, and moderate lochial discharge is present. The gestation sac may break down into a suppurative gangrenous mass, and a process of maceration and suppuration take place, finally ending in expulsion of pus followed by the remains of the fetus, either by way of the bladder, rectum, vagina, or abdominal wall. Or abdominal inclusion of the modified remains of the fetus (**lithopedion**), followed by mummification, calcification, or adipocere formation, may occur. These conditions may be maintained unaltered for many years, or septic infection may occur at any time, with all its attendant dangers.

Tubal abortion results from hemorrhages and contraction of the muscular apparatus of the tube wall in the cases in which the ovum is lodged near the ostium abdominale and the latter remains patent. The ovum is forced through the latter and into the abdominal cavity. This may occur with all the characteristic symptoms which attend rupture of the tube, or these may be but slight or absent altogether, the patient complaining only of mild colicky pains which soon pass off. The comparative frequency of this method of termination of an ectopic gestation is probably overestimated. Thinning and weakening of the muscular coat, together with the occurrence of edematous infiltration, will prevent contraction from taking place, in which case the embryo, in spite of its proximity to the ostium abdominale, will follow the usual course and escape by rupture of the tube.

Treatment.—Operative interference is indicated in all cases in which the diagnosis of ectopic gestation can be made, except only in those instances in which the patient is moribund from intra-abdominal hemorrhage. In doubtful cases the indications for operation rest on the urgency of the symptoms. If the diagnosis is made before rupture, the affected tube and its contents should be removed between two ligatures, one placed on each side of the mass. The raw ends of the stumps thus formed are sewed together. In interstitial pregnancy the sac is shelled out through an incision made through the muscular layers, the resulting bleeding being controlled by deep catgut sutures.

After primary intraperitoneal rupture has taken place the treatment is that of intra-abdominal hemorrhage. The more rapidly progressive the collapse, the more urgently immediate operation is demanded. The abdomen is to be opened at once and the bleeding point found and secured. The patient is to be placed in the Trendelenburg position and everything made ready to infuse the patient with saline solution, either into the cellular tissue (hypodermoclysis), or into a vein if the case is urgent, the moment the bleeding point is secured. The incision should be quickly made, the tube grasped by the thumb and finger, two braided catgut ligatures passed and tied, one on each side of the mass, and the tube cut away. The raw surfaces of the stump are brought facing each other and secured with an over-and-over catgut suture. If septic conditions are present, the infected area should be cleansed with 3 per cent hydrogen dioxid solution (H_2O_2), diluted to one-half strength with sterile saline solution, followed by flushing with saline solution, and drainage effected by means of glass tubes from the pelvis. If the patient's condition will permit it, even in the absence of septic conditions, blood-clots easily accessible may be removed and the cavity flushed with the saline solution. In urgent cases the cavity should be filled with saline solution and the abdominal wound closed as quickly as possible.

In the interstitial variety of ectopic gestation it will not be necessary to remove the tube. The ovum, if it has not already escaped, is to be shelled out and the cavity left closed by catgut sutures.

In subperitoneal rupture, while the pain, as a rule, is more severe than in intraperitoneal rupture, the symptoms of hemorrhage are not so urgent as to demand immediate operative interference. This, however, should not be delayed, since there is danger of septic conditions and the formation of extensive adhesions to the intestines, which will increase the dangers of the operation. **Secondary rupture** in this class of cases demands immediate operation, proper precautions being taken to prevent the spread of infectious material. **Vaginal incision** may be employed in the case of an isolated septic mass situated low down in the pelvis. Should hemorrhage follow vaginal incision, the abdomen must be opened at once and the tube excised.

The continuance of fetal life beyond the fourth month is of rare occurrence in infundibular pregnancy and then only when the rupture has occurred between the folds of the broad ligament (subperitoneal rupture). When the gestation is situated in that portion of the tube passing through the wall of the uterus (interstitial) or in the outer portion of the free tube (ampullar), the fetus may remain and develop in the unruptured tube. In these cases operative interference is rendered more difficult and dangerous by the presence of adhesions, by the occurrence of hemorrhage due to increase in the size of the blood-vessels, and by the development of the placenta. Should the life of the mother be threatened by excessive pain, repeated attacks of localized peritonitis, and recurrent hemorrhages, these will cease almost immediately when the fetus is destroyed. This should be done by inserting a hypodermic needle into some prominent part of the latter and injecting a half grain dose of morphin. The operation may be undertaken three or four weeks later. If the mother's condition does not demand the operation, the surgeon should wait until full fetal development before operating, but not until spurious labor sets in.

The primary object of the operation is the removal of the fetus, and this should be done, if possible, without invading the peritoneal cavity. The incision should be one side of the median line, over the most prominent part of the sac; the latter, which is usually adherent to the parietal peritoneum, is incised, the fetus extracted, and the sac sutured to the abdominal wound. The latter is thoroughly cleansed and packed with gauze. The sac is to be kept clean and drained until the placenta comes away. When the fetus has been dead for some time, the placenta may be found sufficiently loose to come away easily. The sac should be drained in any event and the abdomen tightly bandaged to prevent hemorrhage due to removal of pressure. The sac should not be extirpated except in otherwise uncontrollable hemorrhage, when the uterus should be removed as well.

If, in the efforts of nature to throw off the fetus, the bladder has been invaded by suppuration, this viscus should be opened, preferably from the vagina, and the macerated fetus removed piecemeal. The same may be said of the rectum, the anus being dilated for the purpose.

In cases of **concurrent ectopic and uterine gestation** the rupture of the pregnant tube does not necessarily interfere with the uterine pregnancy (Zinke). The ectopic gestation should be dealt with as in uncomplicated cases, and the uterine child saved if possible.

CESAREAN SECTION

This is an operation by means of which the fetus is extracted by an incision through the abdominal and uterine walls.

The **indications for the operation** are: (1) A contracted pelvis in which the passage of a mutilated fetus is impossible. (2) When the conjugate diameter is from 2½ to 3 inches, and the child is alive (Lusk). (3) Perforating wounds of the pregnant uterus (see page 366), and certain tumors of the uterus.

As between cesarean section and embryotomy, the former should be the operation selected when the child is alive. In a very contracted pelvis embryotomy always sacrifices the child and is as dangerous to the mother as cesarean section. There is, besides, a moral obligation imposed which forbids the sacrifice of a child where it can be saved without exposing the mother to additional risk. The operation should be performed at the commencement of labor in a nullipara; in multiparae it may be performed at full term before labor sets in.

The Operation.—A median abdominal incision of sufficient length to expose the fundus and anterior surface of the uterus is made. An assistant grasps at once both uterine arteries; another holds back the intestines with warm laparotomy pads. The fundus is incised, two fingers of the operator's left hand are passed within the uterus, and the opening rapidly enlarged with these as a guide. The child and placenta are removed together and passed to a waiting assistant. Contraction is secured by manual pressure of the uterus and a hot compress. The incision in the uterus is closed by interrupted sutures of silk, these including the entire thickness of the uterine wall with the exception of the mucosa. The abdominal incision is closed with simple through-and-through sutures of silkworm-gut.

SECTION XX

THE SURGERY OF THE UPPER EXTREMITY

THE SHOULDER GIRDLE OR PECTORAL ARCH

The skeleton of the pectoral arch, consisting of the clavicle, the acromion, and the anterior portion of the spine of the scapula, is preeminently exposed to the influence of direct force. This refers particularly to those portions which lie immediately beneath the skin, as, for instance, the middle third of the clavicle and the acromion, the remaining portions being more or less protected by muscular coverings. The coracoid process, though projecting sharply, is protected by the deltoid and the tendons of its attached muscles.

The pectoral arch is influenced by **indirect** force principally through the medium of the upper extremity. With the arm placed in the position of extreme abduction further movement in the same direction is transferred to the pectoral arch, the movement taking place around an axis of rotation which passes from the sternal end of the clavicle to a point near the center of the scapula (Fig. 671). This is the only axis which permits extensive movements, its point of rotation being equally distant from the edges and angles of the scapula. As this axis passes from in front and inside backward and outward, the movements around it are partly movements of abduction and partly of flexion. Though the movements of the shoulder-joint are very extensive, yet they are limited, and a force applied to compel this movement of combined abduction and flexion may result in driving the clavicle, which is the buttress of the pectoral arch, against the sternal joint surface, a dislocation of the sternoclavicular articulation or a fracture of the clavicle occurring.

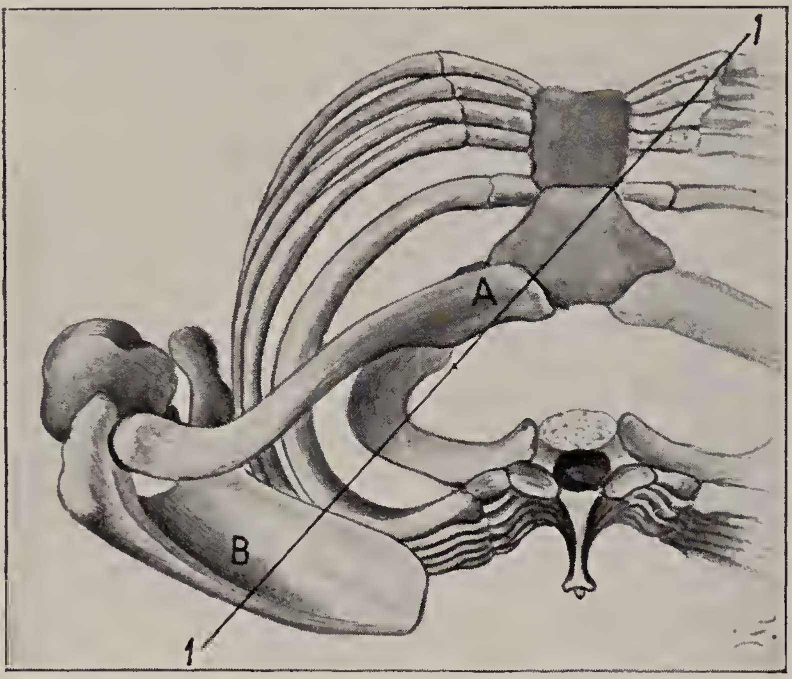

Fig. 671.—Shoulder Girdle Seen from Above. 1, 1, Principal axis of rotation of the shoulder girdle; A, clavicle; B, scapula.

Indirect force is transferred to the clavicle in falls on the external surface of the shoulder with the arm abducted, the elastic thoracic wall, against which the arm rests, protecting the humerus from fracture, the clavicle receiving the force of the blow and giving way at the junction of the middle and external third. This is due to the ⌣⌢ shaped form of the clavicle, the outer curvature being somewhat shorter than the inner. Dislocation of the sternoclavicular articulation by this lateral compression of the pectoral arch is only occasionally observed.

Dislocation of the Clavicle.—The clavicle may be dislocated at either its acromial or its sternal end. Cases of dislocation of both ends of the clavicle are on record.

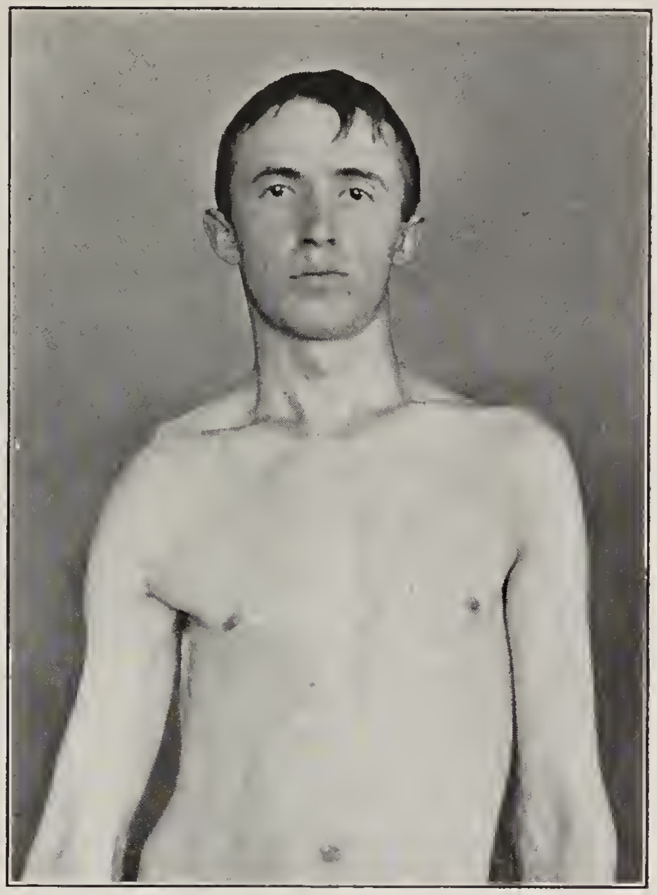

FIG. 672.—DISLOCATION OF ACROMIAL END OF CLAVICLE. FRONT VIEW.

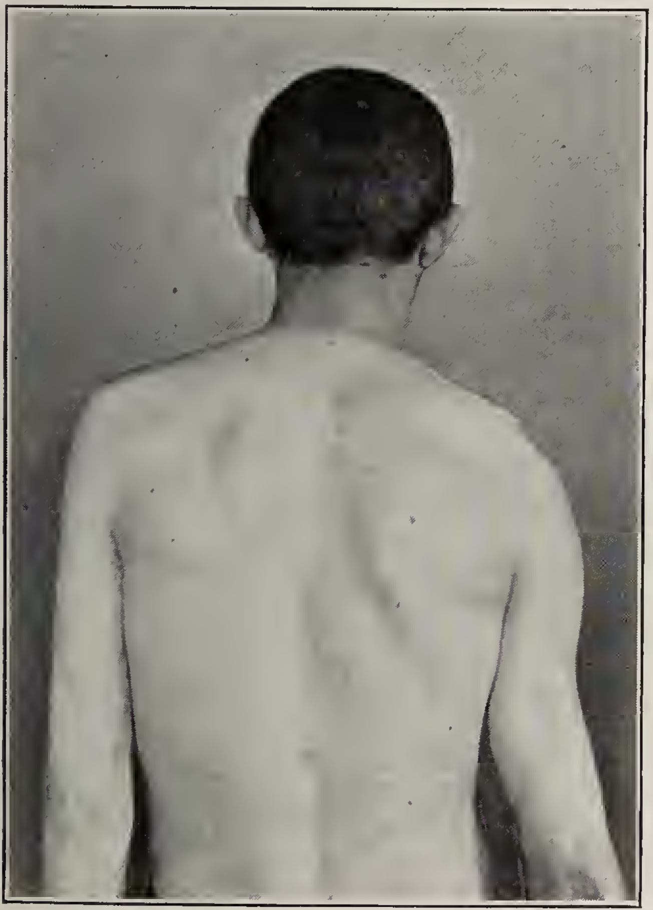

FIG. 673.—UPWARD DISLOCATION OF ACROMIAL END OF CLAVICLE. POSTERIOR VIEW.

Dislocation of the acromial end of the clavicle occurs in either an upward or a downward direction. The **upward** or **supra-acromial** dislocation on the acromion is more common than all the others combined. The scapula is the part that is really dislocated, being driven away from the clavicle by a direct blow from above downward or from behind forward (Figs. 672 and 673). The dislocation may be complete or incomplete, this depending on whether or not the coracoclavicular ligaments are preserved. It may also be combined with fracture. The symptoms in complete dislocation are distinctive and unmistakable. There is a projection of the outer end of the clavicle on the acromion with undue prominence of the trapezius muscle, a tendency to incline the head to the injured side, and downward, inward, and forward displacement of the shoulder; there is apparent lengthening of the arm. The patient cannot place the hand on the top of the head. Reduction is effected by pulling the shoulder back and pressing directly on the clavicle. It is usually easy, though retention is always difficult. Of the nonoperative methods, Rhoades's (Fig. 674) apparatus is the best. Those who are compelled to earn their living by manual labor and in whom there is considerable deformity should be operated on by suturing. This is done by cutting down on the displaced bone along its posterior superior border, replacing it, removing, if necessary, any intervening ligamentous tissue, and retaining the bone in place by silver wire sutures passed through holes drilled in the upper margin of the outer end of the clavicle, and by corresponding ones through the acromion process (Moore).

Or the X-suture of W. B. Hopkins may be employed (Fig. 675). In recent cases suture of the ruptured ligaments by open incision is indicated, with preservation of the articulation.

Downward or subacromial dislocation is very rare. It is caused by direct force applied to the end of the clavicle, as from a blow, or by a fall with the shoulder held rigid, the elbow striking on some hard substance. The acromial end of the clavicle rests on the capsule of the shoulder-joint below the acromion. The **symptoms** are characteristic. These are as follows: absence of the acromial end of the clavicle from its normal position, prominence of the acromion, and a slanting downward of the outer third of the clavicle, which, on being followed by the finger of the examiner, is found to terminate in an abnormal situation below the acromion. Abduction of the arm is difficult and elevation almost impossible. All movements of the arm are painful. Reduction is effected by drawing the shoulder backward or outward and replacing the clavicle by direct pressure from below. It usually stays in place after reposition. Should it not, there is

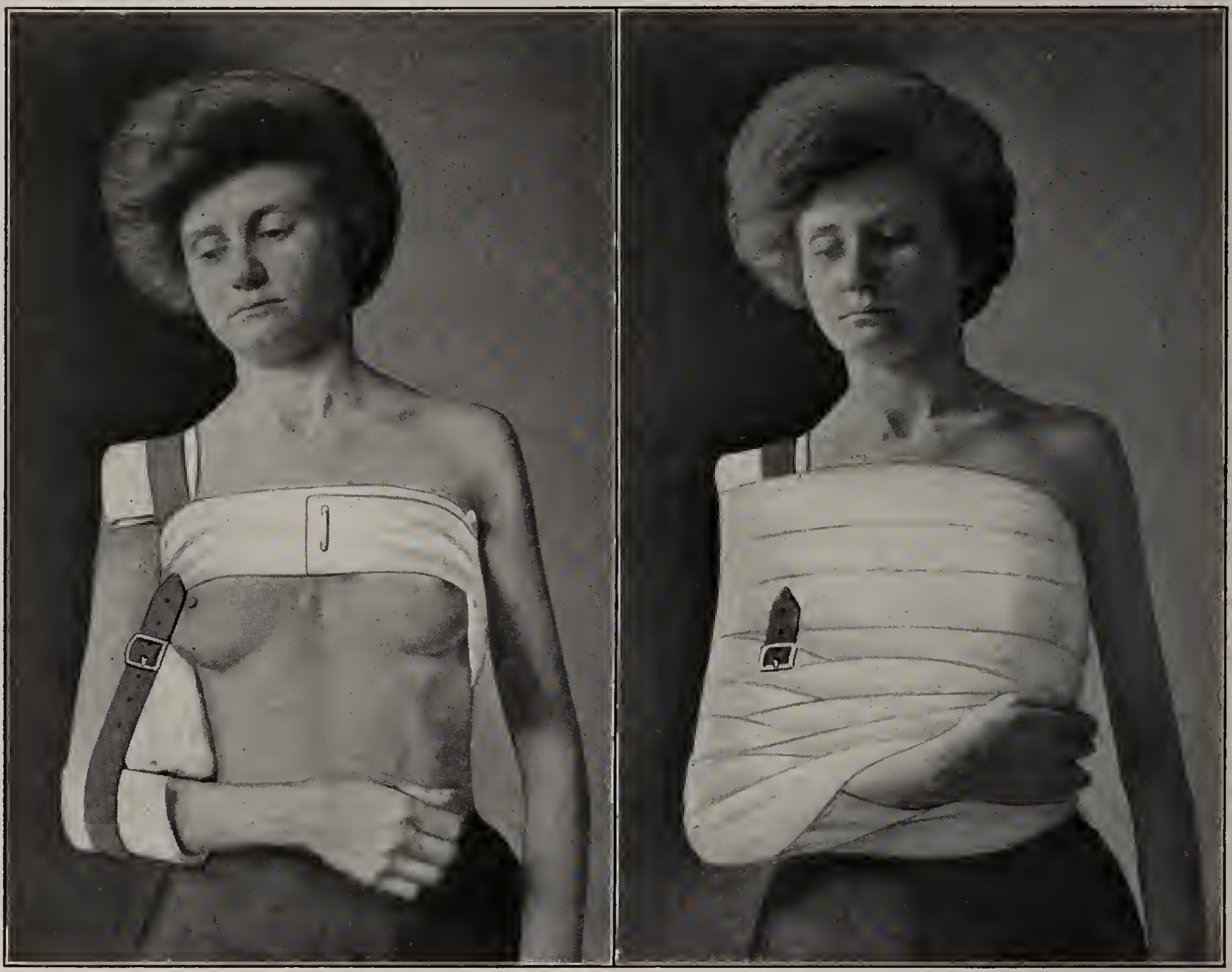

Fig. 674.—Rhoades's Apparatus for Treating Upward Dislocation of Acromial End of the Clavicle.

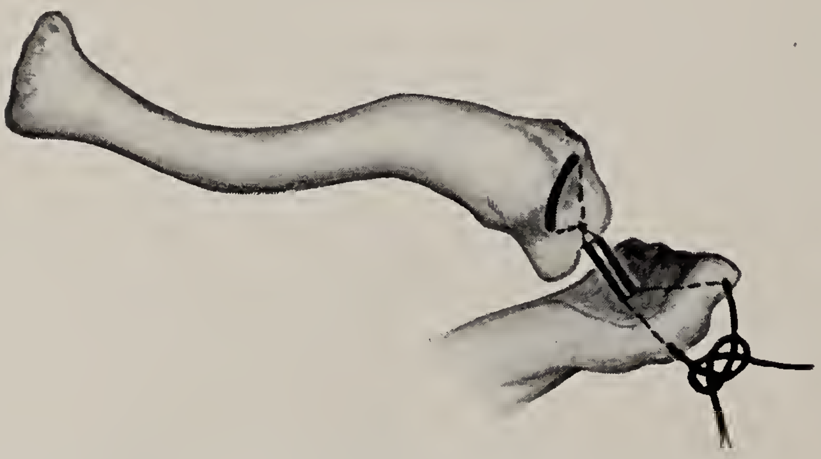

Fig. 675.—Dr. W. B. Hopkins's Suture for Acromio-clavicular Dislocation.

not much functional disturbance; a new articulation forms at the point where the clavicle rests against the lower surface of the acromion.

Dislocation of the sternal end of the clavicle occurs in a forward, an upward, or a backward direction. The forward dislocation is the most frequent; it may be complete or incomplete. The end of the clavicle lies in front of and below the sternoclavicular articulation. The symptoms consist of a prominence in front of the sternum, downward slanting of the clavicle in the inward direction, and depression and adduction of the shoulder. The acromion is nearer the sternum on the injured side than on the sound side. The clavicular insertion of the sternomastoid is rigid and stands out sharply and the head is drawn slightly toward the affected side by tension on this muscle (Fig. 676). Movements of the arm are painful and elevation above the horizontal is almost impossible. The dislocation may be compound, in which case there may be such coincident injuries as fracture of the neighboring ribs, or of the coracoid or acromion. The injury is usually caused by a blow or a fall, rarely by muscular action. Reduction is, as a rule, easy, but retention without suturing is practically impossible. The surgeon places his knee between the shoulders behind and draws the latter strongly backward. Failure to reduce or retain is not a serious matter as far as the use of the arm is concerned. If the deformity is objectionable, the end of the bone may be sutured in position or resected.

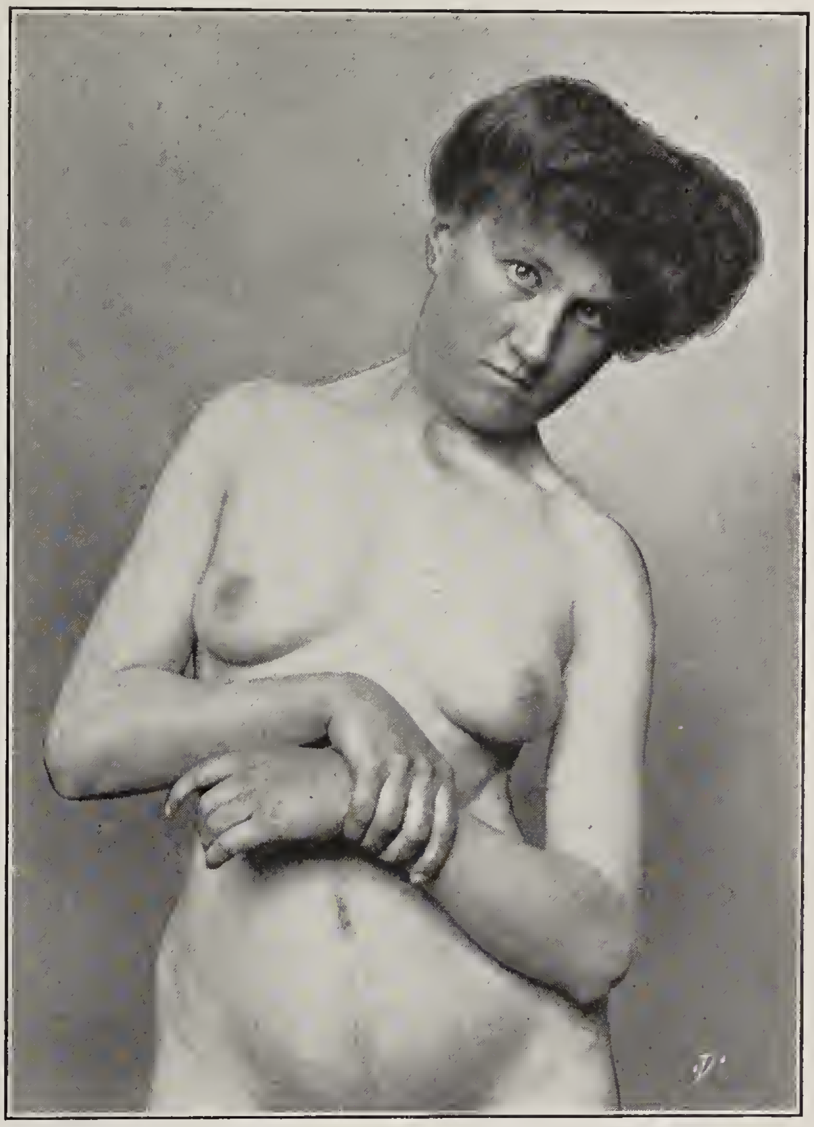

FIG. 676.—FORWARD DISLOCATION OF THE STERNAL END OF THE CLAVICLE.

Backward dislocation of the sternal end of the clavicle, in which the end of the bone lies behind the upper portion of the sternum, is of rare occurrence. A depression exists in place of the head at the sternoclavicular articulation. The movements of both the arm and the neck are restricted, with inclination of the head to the injured side and obliteration of the place of insertion of the sternomastoid muscle. The most important symptoms arise from **pressure** on the trachea, esophagus, and vessels and nerves at the root of the neck. These are dyspnea, dysphagia, weakening of the radial pulse from pressure on the subclavian, and sometimes brain symptoms from compression of the carotid artery and the internal jugular and innominate veins. Movements of the diaphragm may be interfered with on account of pressure on the phrenic nerve. This variety of dislocation may be caused by a blow applied directly on the clavicle in front, but it is more frequently due to a force which drives the shoulder suddenly forward and inward. Reduction is effected by forcing the shoulders backward, the surgeon standing behind the patient with his bent knee between the scapulas. Sayre's dressing for fracture of the clavicle should be applied. If retention is not possible by this means and pressure symptoms are present, the dislocated end of the bone should be resected.

Fractures of the Clavicle.—These are among the most important of the injuries in this region. They are relatively very frequent, Malgaigne claiming for them one-tenth of all the fractures. Pitha estimates them at one-twentieth. Gurlt's estimate is between one-sixth and one-seventh.

They may occur from either indirect or direct violence and at any age. They are specially common among children and are oftener met with before the sixth year. Hulke claims that more than half the recorded cases occur in this period of life. These are usually incomplete or "green-stick" fractures. Fractures arising from direct violence are very rare. They may arise from muscular action, though rarely, as in throwing, in mounting a horse, etc. The usual causes are a fall, the victim striking on the outer surface of the shoulder, and a blow or thrust. The bone usually gives way, under these circumstances, at its weakest point, namely, the junction of the inner or greater curve with the outer or lesser curve, where its diameter is the smallest. The fracture is almost always oblique at this point. Those situated at the outer third are usually from direct violence, are almost always transverse and may be comminuted. Compound fractures of the clavicle, fractures of both clavicles, as well as fractures situated at the inner third of the bone, are so rare as to be clinical curiosities.

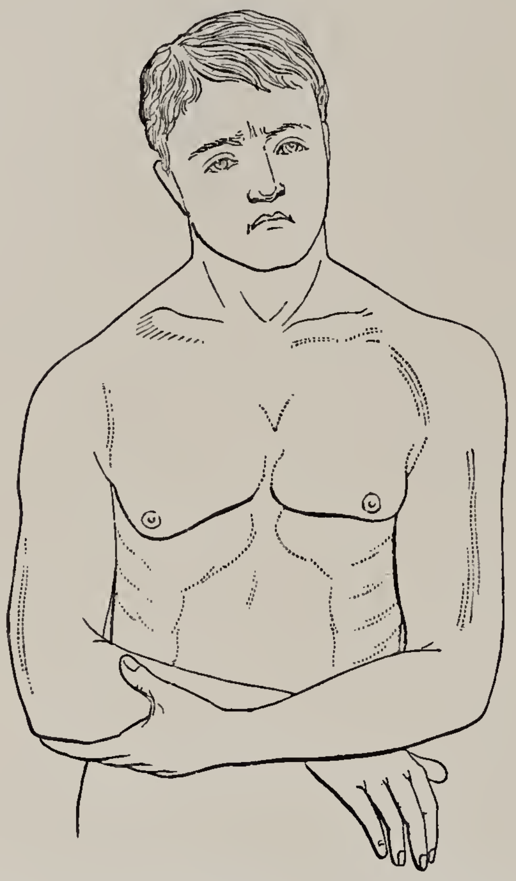
Fig. 677.—Attitude of Patient with Fracture of the Clavicle.

The **symptoms** of fracture of the clavicle are (1) the peculiar attitude of the patient (Fig. 677); (2) the **typic displacement of the fragments.** The shoulder droops and is thrown slightly forward. The patient throws his head toward the injured side in the attempt to relax the tension on the sternomastoid muscle, which is attached to the inner fragment in the common variety. At the same time he supports the forearm with his other hand and rests it against the chest wall. The point of the shoulder is thrown forward by the action of the serratus magnus carrying the scapula forward. In the displacement of the fragments in fractures as usually met with, namely, those of the middle third, the action of the subclavius muscle drags the outer fragment inward, the weight of the arm and the action of the pectoralis major muscle drags it downward, and the action of the sternomastoid drags the inner fragment upward. This results in shortening of the bone, angular deformity, and overriding of the inner fragment. In incomplete fractures the deformity is slight; in those in which the periosteum is untorn it is not so typic. Displacements of the fragments in fractures at the outer third depend on the extent of the coincident injury to the periosteum and ligaments. In well-marked instances the overriding of the fragments is replaced by a marked angular deformity, the weight of the arm dragging the acromial fragment downward, while the trapezius muscle elevates the sternal fragment.

Pressure on the fragments and movements of the arm in eliciting crepitus produce pain in fractures of the clavicle. The diagnosis can usually be readily made by the attitude of the patient and the very apparent deformity of the clavicle. Where the latter is not marked, the symptom of tenderness on pressure at a single point, in connection with the history and the attitude, will suffice.

The **prognosis** is good. The bone unites, as a rule, though there is always more or less irregularity of the contour, and some shortening.

Treatment.—In a child with slight or no displacement a sling for the forearm worn for three weeks is sufficient. The rule laid down in the treatment of green-stick fractures elsewhere, namely, that these should be first subjected to forcible pressure, under an anesthetic, if necessary, to restore the symmetry of the bone, is not to be applied here. This is unnecessary, as well as impracticable, in cases of green-stick fracture of the clavicle. In an **adult with slight displacement** the Velpeau bandage is efficient. In the majority of cases, however, the Velpeau bandage is far inferior to the **Sayre dressing** (Fig. 678), which fulfils the indications of replacement and retention in an admirable manner. Two pieces of rubber adhesive plaster, each about three inches wide and long enough to encircle the chest about one and a half times, are required. The first piece grasps the injured arm between the bend of the elbow and the axilla in a loop (Fig. 678, A), while the remainder of the strip is drawn across the back around to the front of the chest and thence to the middle of the back. The action of this strip is that of a fulcrum; it steadies the arm in a position with the elbow thrown back and the shoulder thrown forward. When the arm is now thrown forward, it serves as a lever acting against the loop of the first piece as a fulcrum (Fig. 678, B), and as the elbow is brought forward and

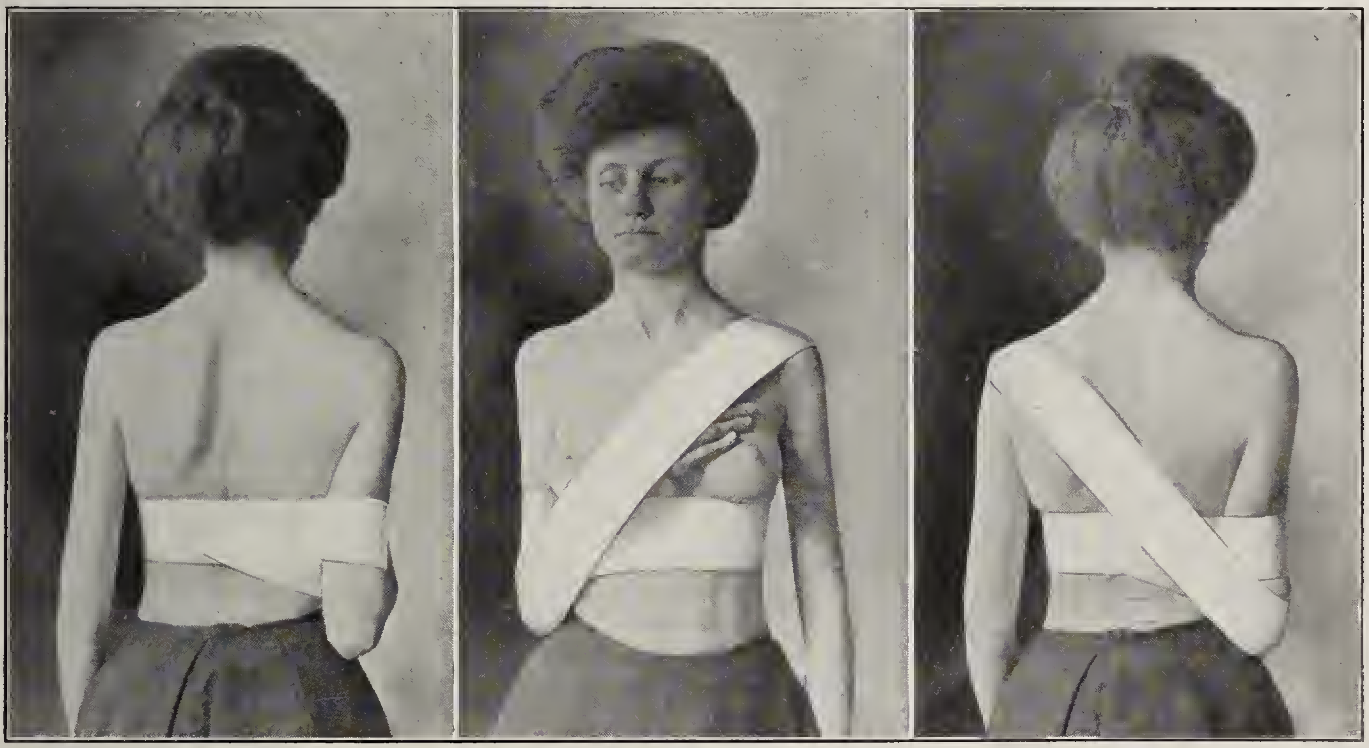
A B C

Fig. 678.—Sayre's Adhesive Plaster Dressing.

inward (over the chest wall) the point of the shoulder is pried backward and outward, carrying the outer fragment with it. This results in as perfect reduction of the deformity as can be obtained without section of the clavicular insertion of the sternomastoid or the wiring of the fragments. A few turns of a canton flannel roller around the arm before the application of the loop will prevent excoriation of the skin at this point.

In cases in which the fragments cannot be brought into coaptation because of the presence of interposed muscular tissue, they may be **sutured** with kangaroo tendon, chromicized catgut, or silver wire, after the fragments have been cleared and drilled.

Complications in fractures of the clavicle are rarely observed. Exceptionally, and in cases of comminuted fracture, the brachial plexus, the subclavian artery and vein, and the lungs have been injured.

If other injuries are sustained at the same time and the patient is compelled to lie in bed, no dressing need be applied. The recumbent prone position fulfils all the indications.

Tumors of the Clavicle.—Tumors of the clavicle are practically limited to **syphilomas,** which, on the supervention of suppuration, produce caries. The latter, if near the sternal end, may extend to the sternoclavicular articulation and result in destruction of this joint. The local and general therapeutic measures employed in syphilitic lesions elsewhere are alike applicable to these manifestations of the disease.

Sarcoma of the clavicle is observed only exceptionally. It usually originates near the middle of the bone. Central sarcoma usually arises near the sternal extremity. Excision of the entire clavicle has been performed and is the only justifiable operative resource in this class of cases.

THE SCAPULA

Fractures of the Scapula.—These are very rarely observed. The mobility of the bone and its covering of thick muscular structures protect it against injury. These latter act as a "buffer," and a crushing blow sufficient to fracture the unprotected scapula is usually transferred to the elastic chest wall underneath, a fracture of the ribs resulting. The following forms have been observed: (1) fractures of the acromion; (2) fractures of the coracoid process; (3) fractures of the neck of the scapula; (4) fractures of the body of the scapula.

Fractures of the acromion are the most common of the fractures of the scapula. They arise almost exclusively from **direct violence** by blunt force applied from above, separating the point of the acromion process and displacing it downward against the head of the humerus. Exceptionally they may arise from **muscular action** in forcible elevation of the arm. Under these circumstances the action of the deltoid and the weight of the arm tend to drag the fragment downward. The displacement is rarely considerable in any case, the action of the trapezius serving to counteract it. The **line of fracture** runs either obliquely or transversely, but this is exceedingly difficult to make out. There is **pain on attempting to elevate the arm,** and **tenderness at the site of fracture, with crepitus,** on palpation. The latter can be best elicited by pushing the arm up and down.

The treatment consists in placing the arm in a sling and bandaging it to the side of the chest with a folded cotton compress between. Bony union, when it takes place, follows in from three to four weeks. The fragments frequently unite by connective tissue, pseudarthrosis resulting, in which case the patient can raise the arm only to the horizontal. If the disability is considerable, suturing may be resorted to, in which case the incision will invade the subdeltoid and subacromial bursa. The disability is rarely sufficient to justify suturing.

Fractures of the Coracoid.—These usually occur in connection with some other injuries, as, for instance, with fracture of some other portion of the scapula. When occurring alone, they arise from **muscular action,** the forearm being strongly extended, the entire arm attempting a forcible movement. They may be produced by the strong impact of the head of the humerus in dislocation. If the coraco-acromial ligament is ruptured, the coracoid is displaced downward and inward by the action of the biceps, the coracobrachialis, and the pectoralis major muscles. Crepitation is rarely obtained. The **diagnosis** may be made by **Hueter's test movement,** *i. e.,* **when the hand is placed in the supine position and the patient flexes the arm, pain will be felt at the site of the coracoid.** The same movement with the hand in pronation is painless. This depends on the fact that when flexure of the forearm takes place with the hand prone the biceps is prevented from acting as a flexor unless it can first act as a supinator by rolling the radius into supination, and therefore the coracobrachialis acts by drawing the humerus forward and inward and flexes it while the brachialis anticus performs the flexion, the coracobrachialis also assisting in flexion. With the hand supine the flexion is performed by the biceps, the coracobrachialis not acting, and the patient involuntarily refraining from bringing into use the short head of the biceps, producing the flexion by the long head alone, which is not attached to the coracoid process. With the hand pronated and supinated on one's own person one may demonstrate this action of the biceps in flexion as well as that of the coracobrachialis. This sign will also be present in contusions and ruptures of the muscle, but the pain will not necessarily be felt at the coracoid process. It is also observed in rupture of the long head of the biceps.

Fracture of the coracoid process is treated by fixation of the arm to the thorax, with the forearm flexed and the arm adducted. The union is fibrous but no disability results.

Fractures of the Neck of the Scapula.—These are divided into (1) fractures of the glenoid cavity; (2) fractures of either the anatomic or the surgical neck. Fracture of the anatomic neck, *i. e.,* that compact constricted portion of the bone just behind the glenoid fossa, is very rare and cannot be distinguished clinically from fracture of the surgical neck. The line of fracture of the latter usually runs from the suprascapular notch obliquely downward to a point below the glenoid cavity. In this case the fragment carries with it the coracoid process. Rarely the line of fracture passes outside the base of the coracoid, and below it and the upper limit of the glenoid. The **diagnosis** is often confused because of the appearance of the extremity, which resembles that of dislocation of the humerus into the axilla, with its flattened shoulder, prominent acromion, and a distinct deviation of the arm toward the axilla. On the other hand, the facts that **both active and passive movements, though painful,**

are possible, crepitus obtainable by movements, the **deformity easily reducible** by simply pushing the arm in an upward direction, and, finally, that the **deformity returns as soon as the upward pressure is released,** at once remove the possibility of error.

The **treatment** in cases in which the displacement is slight consists in applying a Velpeau bandage (page 691). Where the deformity is considerable and not easily reduced, the **reposition should be done under an anesthetic,** a wedge-shaped cushion of cotton placed in the axilla to maintain the fragment in place, and a plaster-of-Paris Velpeau applied. Bony union always takes place, and the movements of the arm are in large measure restored. Elevation of the arm and rotation may be more or less impaired for a time.

Fractures of the body of the scapula result from direct violence. They are either simple fissures or fractures without essential displacement, except in cases in which the line of fracture runs transversely and at the lower angle. In such a case the lower fragment will be drawn upward and forward by the serratus magnus and teres major muscles. The treatment consists in placing the arm in a sling and fastening the arm and scapula to the chest wall by a water-glass, or plaster-of-Paris bandage. Bony union takes place promptly. There may be some overriding of the fragments but there is no disturbance of function. Abscesses readily form in compound comminuted fractures.

Gunshot Wounds of the Scapula.—These have a special importance from the fact that they are usually accompanied by **extensive splintering,** particularly when they occur at the brittle middle portions of the bone. Suppuration easily takes place, which extends by preference into the extensive connective tissue between the subscapular and the serratus magnus, and between the latter muscle and the thoracic wall. The resulting septic and pyemic conditions must be met by adequate drainage, which must be secured by removal of the splinters and perhaps by partial resection of the scapula. There is very slight disturbance of function resulting from these operations, except that which arises from the cicatricial tissue which forms between the scapula and the chest wall. **Persistent hiccough** was observed by Pitha in suppuration of the scapular region. This peculiar symptom is explained by the fact that the suprascapular and phrenic nerves have their origin close together at the cervical plexus, the spasmodic movements of the diaphragm being produced by the irritation of the suprascapular nerve.

Dislocation of the lower angle of the scapula, so called, has been thought to be due to the slipping of the bone from under the latissimus dorsi by the same mechanism which produces dislocation of the shoulder in forced abduction, the force, however, expending itself on the scapula. It is now, however, believed to be due to **paralysis of the serratus magnus,** the bone being acted on by the trapezius, pectoralis minor, levator anguli scapulae, and rhomboid muscles. The **treatment** includes electricity and massage of the affected serratus magnus and the deep injection of strychnin.

Sarcoma of the scapula and its immediate environment springs either from the superimposed soft parts, from the periosteum, or from the medullary structure of the bone. The last form originates, in most instances, from the medullary tissue of the neck of the scapula, or at the coracoid process, while the first two usually spring from the margins and surface of the scapula. These two forms can scarcely be separated clinically, for the reason that their mobility on the bone itself cannot be recognized. In a fortunately early case there is a possibility of excision of the scapula, but the instances must be few and far between in which such a course would not be followed by recurrence. The sarcomas springing from the periosteum and from the medullary tissue of the bone demand complete removal of the scapula. Sarcomas in this bone frequently attain a large size and are the seat of extensive chondrification and ossification. The spindle-celled species predominates.

Excision of the scapula for sarcoma is to be performed without preservation of the periosteum coverings. Langenbeck's incision extends from the tip of the acromion to the superior angle of the bone, and thence along the vertebral border to the inferior angle. The following plan gives rather more room than Langenbeck's. It consists of two longitudinal and a transverse incision. The first incision is carried along the vertebral border from the upper to the lower angle of the bone. The second commences at the acromion and follows the direction of the axillary border for nearly one-half of the distance to the lower angle, or just below the point of insertion of the scapular or long head of the triceps. These two incisions are connected by a transverse incision which commences at the termination of the second and crosses the spine of the scapula to join the first (Fig. 679; Reid). After the cutaneous flaps have been turned back the muscles which fix the scapula to the trunk are separated, namely, the trapezius and deltoid from the spine and the acromion, the omohyoid from the upper border, the rhomboid and the levator anguli scapulae from the vertebral border, and the teres minor and teres major from the outer border and the lower angle. The scapula is now sufficiently loosened to be lifted at its inner border, when the serratus magnus and the subscapularis are divided. The joint capsule is now freely opened above and the insertions of the supraspinatus and the infraspinatus divided at the greater tuberosity. The acromioclavicular joint is now opened, the scapula is rotated outward, the division of the capsule completed and the biceps and triceps tendons separated at the edge of the glenoid cavity. Finally, by cutting away the coracoid insertions of the pectoralis minor and the coracobrachialis the bone comes away. The posterior scapular artery is tied at the vertebral border and upper angle, and the suprascapular as the trapezius and deltoid are separated.

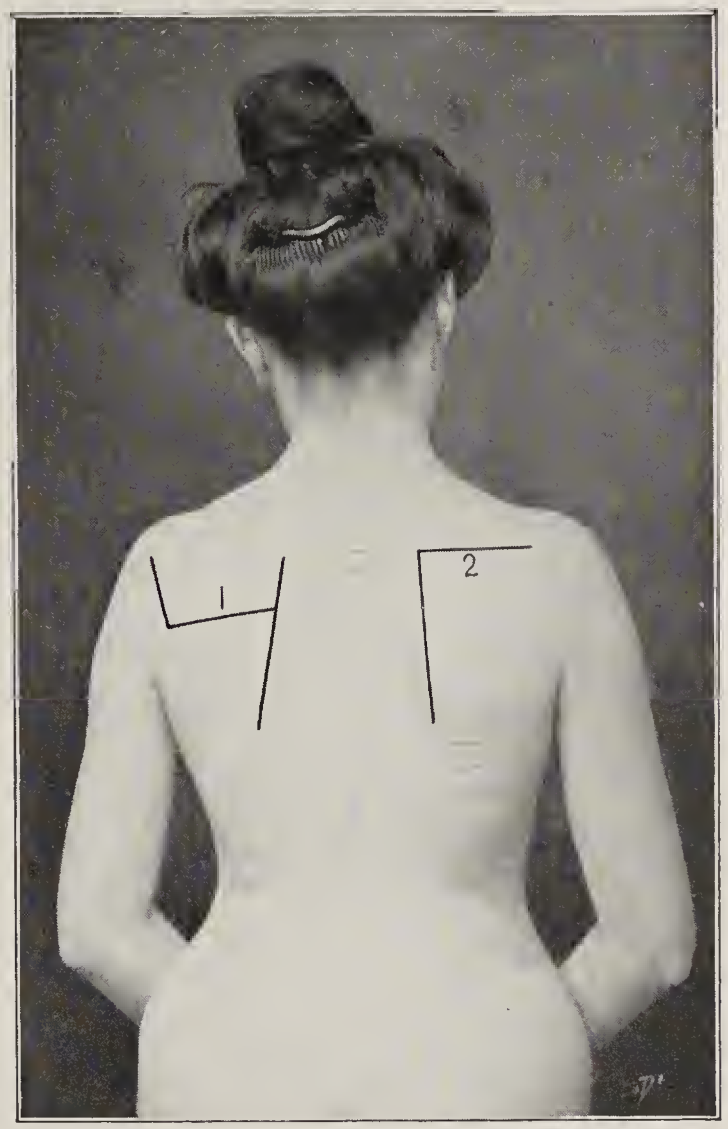

Fig. 679.—Excision of the Scapula.
1, Reid's incision; 2, Langenbeck's incision.

The dorsalis scapulae branch of the subscapular is secured by double ligation where it winds around the inner edge of the bone beneath the teres minor.

The remains of the capsule should be sutured to the muscles and the head of the humerus approximated to the inferior surface of the acromial end of the clavicle. There is no advantage in retaining the glenoid cavity by sawing across the neck of the scapula in the operation, even if this were permissible, as in the case of benign tumors, for the reason that the mortality is not diminished, or the usefulness of the extremity increased by such a course.

THE SHOULDER-JOINT

Injuries of the Shoulder-joint.—Gunshot wounds of the shoulder-joint are not rare, on account of the prominence and exposure of this region of the body. The missile almost invariably makes either a **furrow,** injuring the head, tubercles, and joint surface, or a **channel,** passing through the head, and producing, in case of the old-fashioned bullet, excessive splintering. In the case of the modern small-bore hard bullet with high velocity the channel is clean-cut, like the passage bored by a machine auger through a piece of hard wood. In the splintered wounds of the surgical neck or adjacent portions of the shaft of the humerus, the bullet may inflict damage on the thick cortical lamella. Fissures from the fracture frequently extend into the joint capsule and into the head of the humerus. These injuries are very dangerous, septic conditions supervening rapidly with hyperacute suppurative inflammation within the joint, accompanied with high fever. With the Mauser or other missiles of its class there may be but a low grade of inflammation with scarcely any reaction. During the Greco-Turkish War I saw, through the courtesy of Professor Djmil Pasha, Surgeon-General of the Turkish army, a number of cases of gunshot wounds of the shoulder in which there was practically no suppuration; the same experience was repeated in the Spanish-American War. In cases of suppuration about the joint, in which there is any doubt as to the involvement of the articulation, pressure may be made from the direction of the axilla to test the sensitiveness of the joint.

While complicated injuries of the shoulder-joint are rare in civil life, yet this part of the body possesses a special interest for the surgeon because of the uncomplicated, though serious injuries to which it is subject. There are three groups of these, namely, (1) contusions with **simple hemorrhage into the joint;** (2) dislocations; (3) fractures of the bones comprising the joint, including the anatomic neck of the humerus, fractures of which sometimes involve the surgical neck and the greater and lesser tuberosities.

By the term **simple hemorrhage** is meant hemorrhage within the joint from contusions of the capsule. This may be felt as a fluctuating swelling at the anterior and posterior edge of the deltoid muscle. It is not to be confounded with that which accompanies dislocations and fractures. The treatment consists in the application of ice-bags or ice compresses, and a supporting bandage. The blood is usually rapidly absorbed. Permanent synovial effusion is rare and suppuration scarcely ever occurs after such an injury.

Dislocations of the Shoulder-joint.—These constitute rather more than 50 per cent of all the dislocations observed in the body. The comparative frequency of these injuries arises from the slight depth of the glenoid cavity and from the fact that the latter incloses only about three-fourths of the head of the humerus, from the slight solidity which the joint possesses, its free mobility, and finally the absence of external supporting structures to the lower and inner capsular wall of the joint. In certain movements of the shoulder-joint the long lever of the arm is efficient in producing dislocation, as, for instance, that of superabduction of the arm. The only bony check to the various movements of the arm, viz., flexion, extension, abduction, adduction, and internal and external rotation, occurs when the cartilaginous brim of the glenoid cavity comes in contact with the furrow of the anatomic neck of the humerus. The humerus may be displaced in any one of the following directions:

Anterior	Subcoracoid	
	Subclavicular	(supracoracoid,
Downward	Axillary	
	Subglenoid	(erecta)
Posterior	Retroglenoid	(subspinous,

Subcoracoid Dislocations.—These embrace three-fourths of all the shoulder-joint dislocations. They may result from direct force, by the driving of the head of the humerus forward and inward, but in the great majority of cases they are caused by falls on the hand or elbow, with the arm in a position of superabduction.

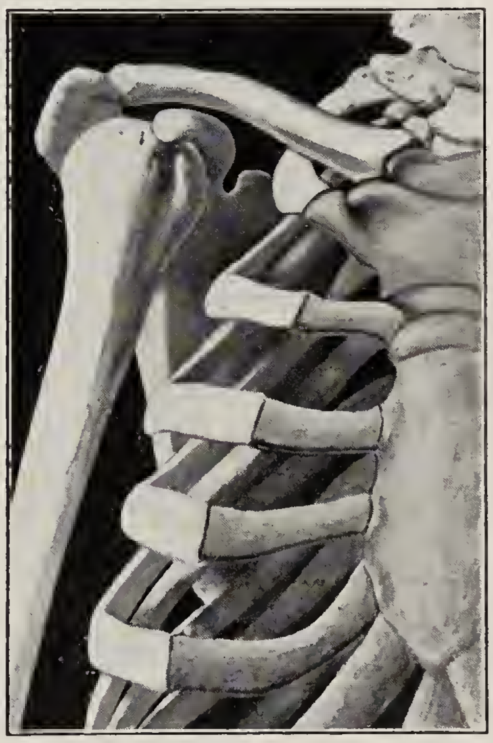

Fig. 680.—Subcoracoid Dislocation of the Humerus.

Extreme physiologic displacement of the arm from the thoracic wall constitutes combined abduction and flexion, the former prevailing. Traumatic exaggeration of this movement may be surgically considered, however, as superabduction. The deepest portion of the furrow at the anatomic neck is crowded against the upper edge of the glenoid cavity, the head of the bone moves on the greater tuberosity as a center and is forced against the weakest portion of the joint capsule, *i. e.*, the lower and internal capsular wall, which gives way, the head passing into the axillary cavity through the resulting fissure. The dislocating force is now exhausted and a secondary movement of adduction takes place, not, however, on the axis passing through the head of the humerus, as under normal conditions, but around an axis situated at the level of the still intact portions of the capsular ligament, namely, the upper and external portions. In this movement the elbow falls in the direction of the lateral chest wall, and the head of the bone rises from the axillary cavity and finally rests beneath the coracoid process of the scapula. Complete adduction is prevented by the still intact but overstretched portions of the joint capsule.

Dissections of recent cases of this dislocation reveal the head of the humerus resting against the neck of the scapula; in some instances it is buried in the fibers of the subscapularis muscle, which is usually more or less torn. The large vessels and nerves as they issue from the lower edge of the pectoralis minor to pass through the axillary cavity to the arm are deeply placed at the inner surface of the dislocated head. Occasionally the long head of the biceps is twisted around the surgical neck of the humerus. More frequently, however, this is either ruptured or passes obliquely from the point of the glenoid cavity to the arm.

The **diagnosis** is often made by inspection alone (Fig. 681). The arm is seen to be slightly abducted; in recent cases the patient instinctively supports it in this position. The contour of the shoulder is flattened above and a depression exists below the acromion. The globular shaped head in its abnormal position is visible in front. Excessive extravasation may mask these appearances.

By palpation the head of the humerus is felt in its abnormal position. If doubt as to its identity exists, rotation of the arm will cause the head to roll on the finger. Mobility is restricted in all directions; the head impacted in the space bounded by the scapula, the coracoid process, and the chest wall, cannot be moved without excessive pain. Complete adduction is impossible. With the hand placed on the opposite shoulder it will be found impossible to bring the elbow of the affected arm to rest on the chest wall. Slight abduction can be made.

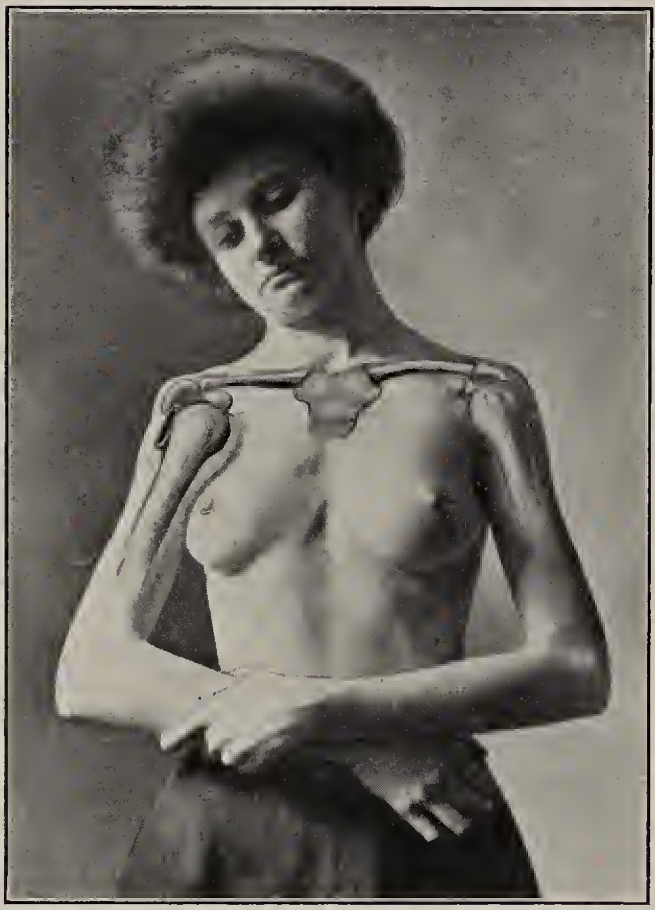
Fig. 681. — Subcoracoid Dislocation of the Humerus.

Symptoms arising from pressure on the brachial plexus are quite constantly present. Tingling sensations and numbness are felt in the finger-tips; spasmodic or convulsive movements may attack the muscles of the forearm and fingers. In case of long-continued or great pressure, or rupture of a nerve-trunk, paresis or paralysis in the distribution of the latter will be present. Edema of the extremity arises from pressure on the axillary vein and lymph-channels. The vein may be ruptured and give rise to a large extravasation of blood. The artery, however, is more frequently compressed or injured. Paralysis of the deltoid muscle is sometimes present as a result of injury of the circumflex nerve.

The Reduction of Subcoracoid Dislocation.—The physiologic methods of reduction of dislocation of the shoulder will only be considered in this connection. The method by extension alone, as well as that of Sir Astley Cooper by means of pressure with the heel in the axilla and extension combined, is now very generally abandoned.

The method by **simple manipulation** involves, in all probability, the same maneuver as that employed by Abernethy, which he called "reduction by strategy." The method is usually known as that of Mothe, though it was recommended in the last century by White. The patient is placed in a chair or laid on a hard mattress. A strong towel is passed around the clavicle, scapula and shoulder, its two ends meeting in a downward direction, where they are firmly held by an assistant. A second towel embraces the thorax and is secured on the healthy side. With this fixation complete all movements made for the purpose of reduction affect principally the humerus itself. The arm is now brought into the position of superabduction, the original position assumed when the accident occurred. With one hand making traction in the direction of superabduction, the other makes pressure against the head of the bone and moves it in the direction of the axilla and glenoid cavity. The arm is now firmly adducted against the operator's fist held in the axilla (Bruns), the head of the humerus sliding into the glenoid cavity. In recent cases this is announced by a distinct and characteristic sound or snap. The restoration of the contour and normal movements of the shoulder will follow reduction.

Simon's Method.—This is known as the pendulum method. The patient is placed on the floor or on a very low mattress. The surgeon stands on the diseased side, on a chair, and draws the abducted arm upward. The entire weight of the patient's body hangs on the luxated joint and extends the superabducted arm. Reduction is sometimes accomplished in this manner. In some cases the surgeon grasps the patient's arm, while an assistant holds the legs of the patient so that he is literally suspended. The mechanism of the reduction by Simon's method is practically the same as that by Mothe's, but fewer assistants are required.

Schinzinger's Method.—The patient is laid on a hard table. The elbow is bent at a right angle and rotated strongly outward, the forearm being employed as a long lever. When rotation is nearly complete, the arm is forced in an upward direction, the manipulation ending with an inward rotation of the arm, the head of the bone passing into the glenoid cavity. The great leverage obtained by the forearm, in this method, in rough or unskilful hands has led to fracture of the surgical head of the humerus. The upper part of the capsule and the coracobrachial ligament are not so completely relaxed as in Kocher's method.

Kocher's Method.—This is a modification of Schinzinger's method. The patient is placed in the dorsal position on a table. The arm is grasped above the elbow-joint by one hand, the forearm is flexed at a right angle to the arm, and the tendency to abduction is overcome by forcing the arm against the chest wall. While making traction (in accomplishing which an assistant, standing near the patient's head and forcing the arm in a downward direction by grasping it just below the shoulder-joint, may be very useful), the entire extremity is rotated strongly outward until the forearm points laterally and the palm of the hand looks directly forward (Fig. 682). The arm, still maintained in rotation and drawn strongly downward, is now carried directly forward as far as possible (Fig. 683). Lastly, with the arm in this position, the forearm is carried inward across the chest to the other side, while, at the same time, the arm is rotated inward, the head entering the glenoid cavity with a perceptible jerk (Fig. 684).

The mechanism of the reduction is as follows: In adduction and outward rotation the intact capsule and the strong coracobrachial ligament are placed on the stretch, and act as fixed points on which the head of the bone rotates and approaches the glenoid cavity. When the arm is elevated to the horizontal position after outward rotation, the coracobrachial ligament and capsule, which,

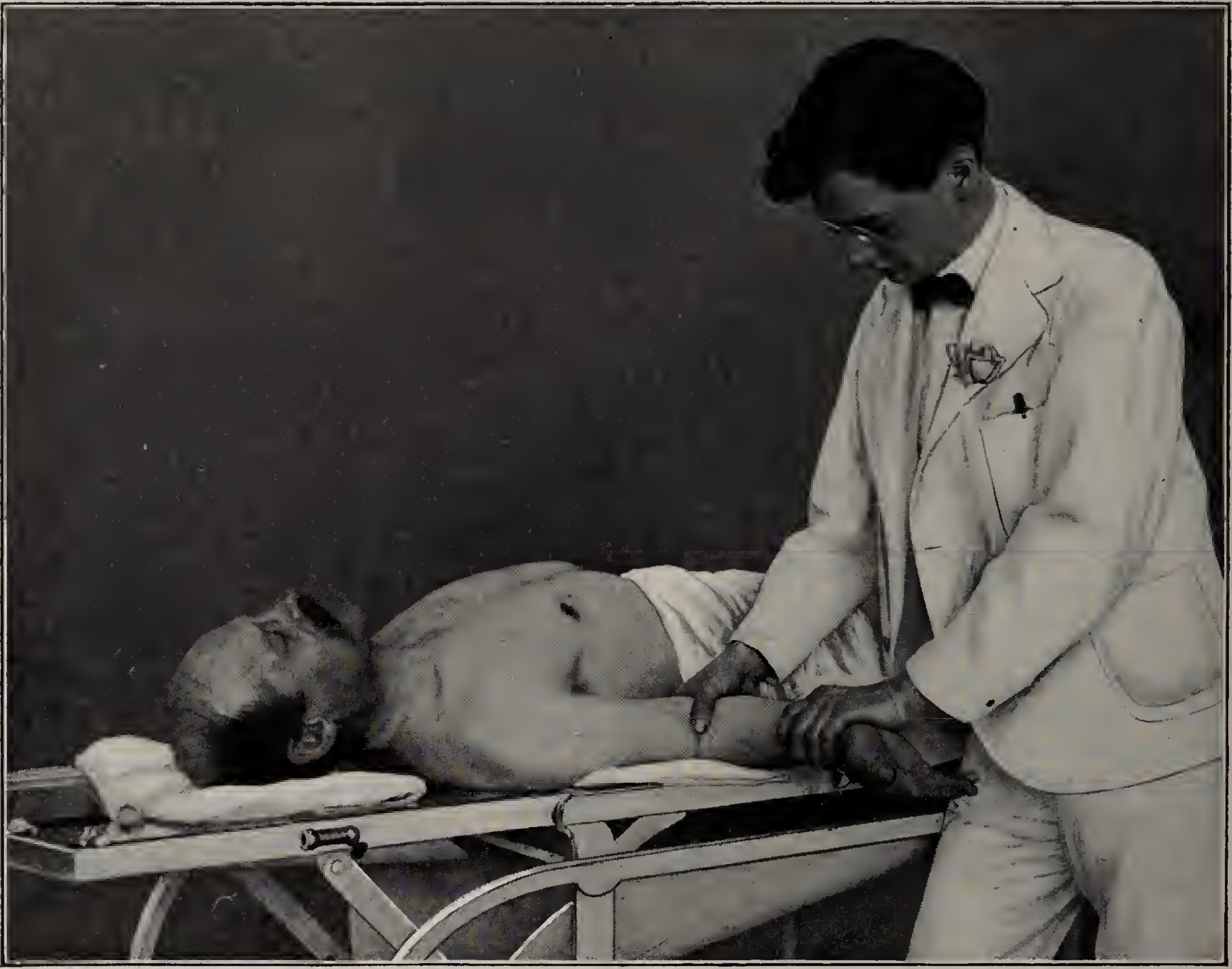

Fig. 682.—Reduction of Dislocation of Shoulder by Kocher's Method. The First Movement. The entire extremity is shown rotated strongly outward until the forearm points laterally and the hand looks directly upward.

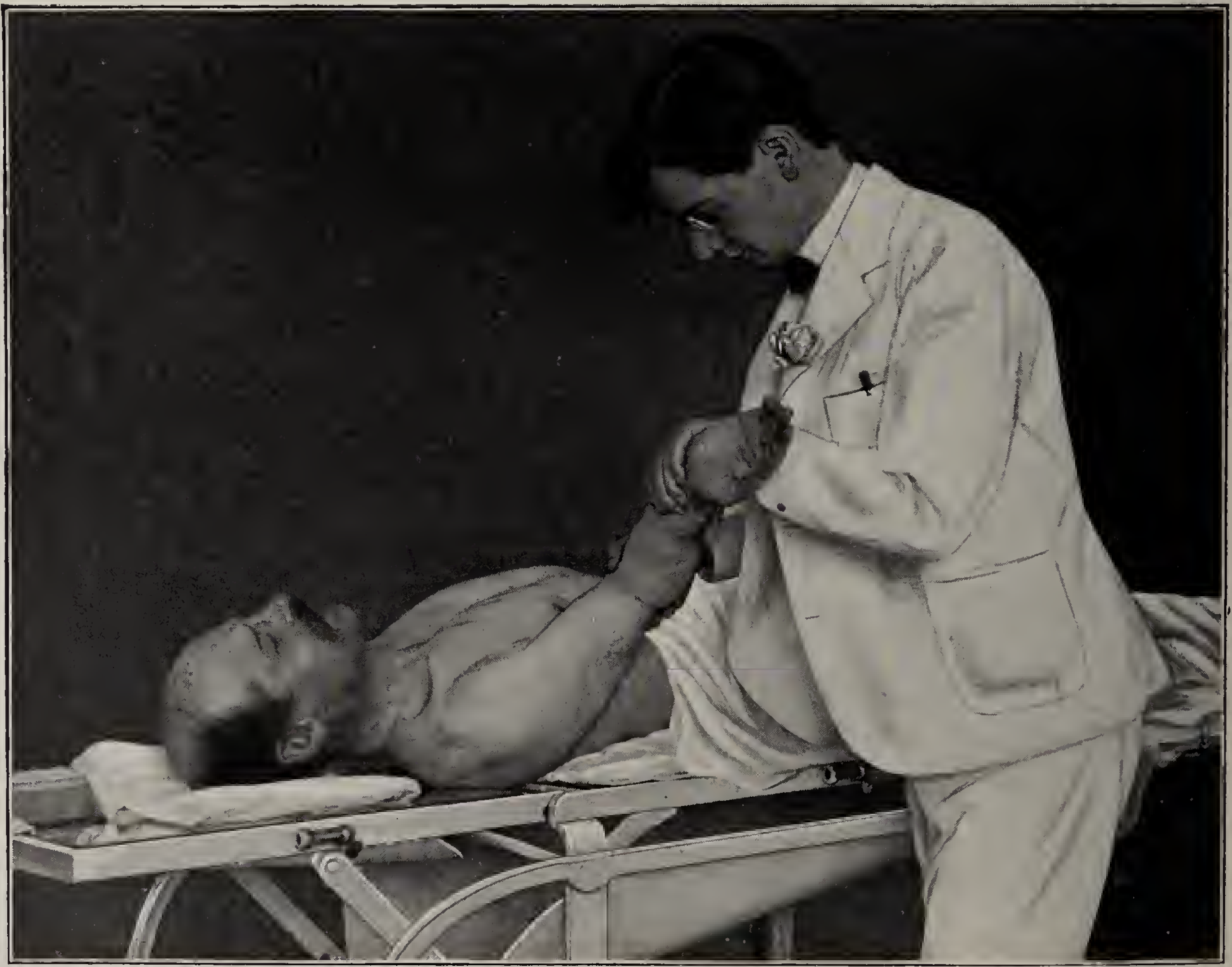

Fig. 683.—Reduction of Dislocation of the Shoulder by Kocher's Method. The Second Movement.

The arm is shown maintained in strong rotation, drawn strongly downward, and carried directly forward as far as possible.

prior to this stage of the manipulation, embarrass the further progress of the head of the bone toward the glenoid cavity, are relaxed.

Stimson's Method.—In this method the muscular resistance is overcome

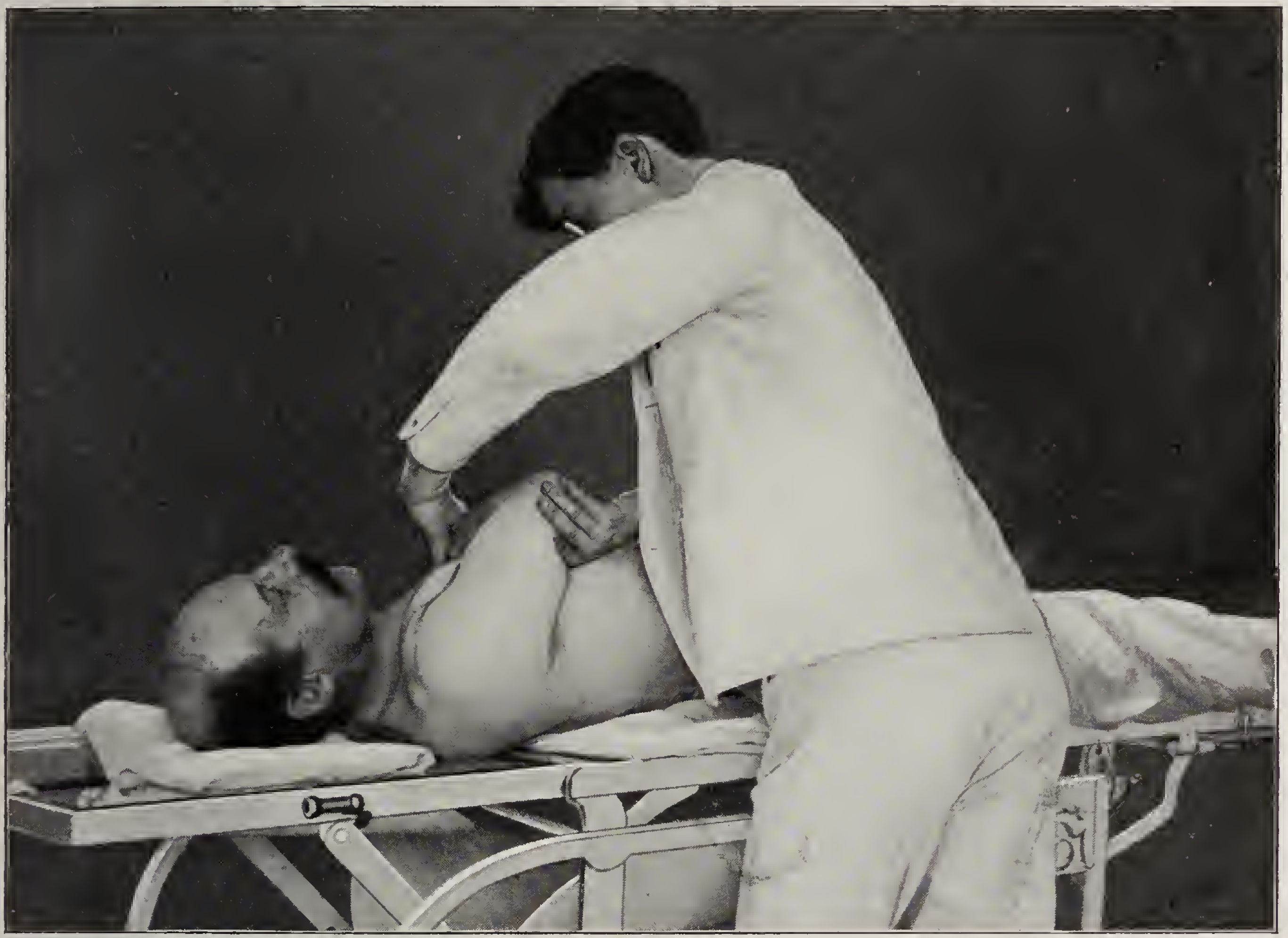

Fig. 684.—Reduction of Dislocation of the Shoulder by Kocher's Method. The Third Movement. The forearm is carried inward across the chest to the other side, while at the same time, the arm is rotated inward.

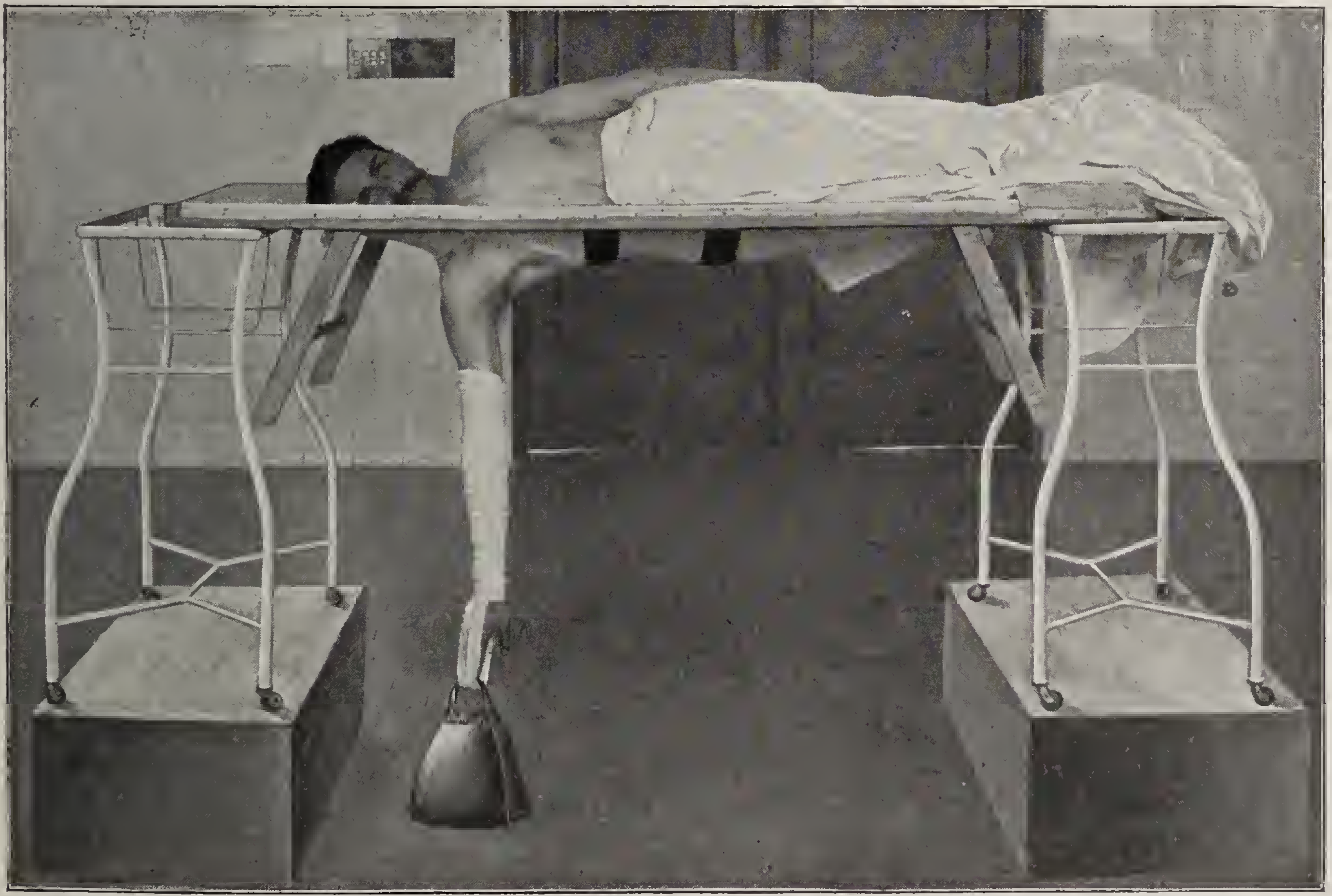

Fig. 685.—Stimson's Method of Reduction of Dislocation of the Shoulder. Improvised support for the patient's body and weight attached to arm.

by continuous extension by means of weights attached to the arm. The patient is laid on the same side as that on which the injury occurred and the arm is passed through an opening cut in the table or cot. The arm is then weighted with 10 pounds at first; 10 pounds are added at intervals of from one to two minutes up to 40 pounds. In from five to fifteen minutes the parts are sufficiently relaxed and the head advanced toward the glenoid cavity to permit easy completion of the reduction by adducting the arm against the fist placed in the axilla (Figs. 685 and 686). Sometimes the head slips in itself.

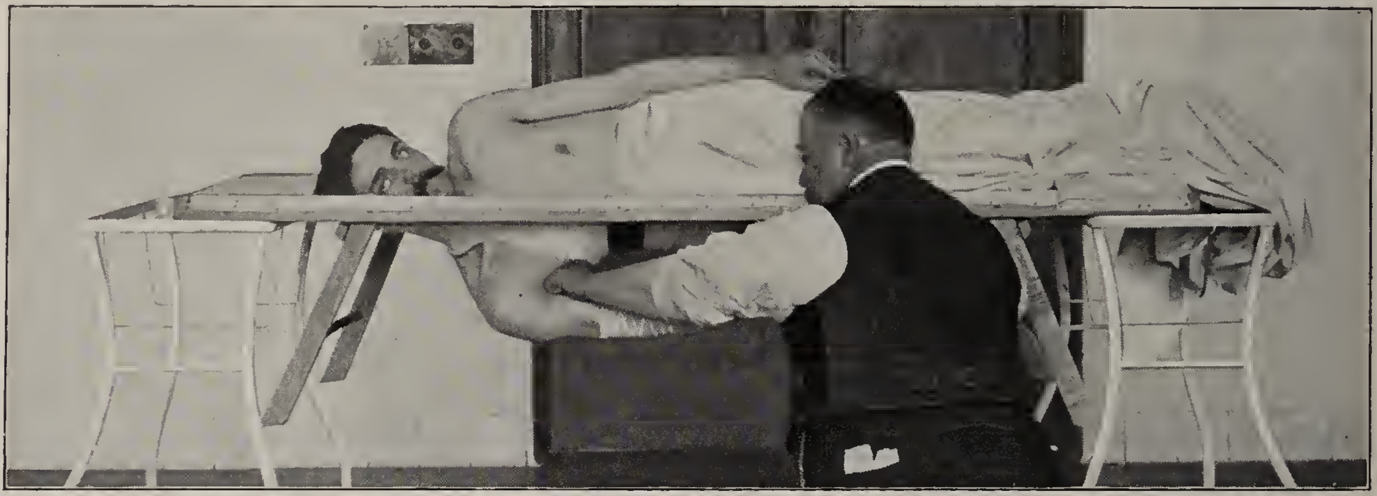

Fig. 686.—Stimson's Method of Reduction of Dislocation of the Shoulder. Adduction of the arm with the closed fist in the axilla.

If the dislocation is properly reduced, full restoration of function will follow in time, provided methodic passive movements, particularly those of abduction, are not neglected. These should be cautiously commenced at the end of a fortnight, the arm in the meanwhile being supported in a sling or supporting bandage.

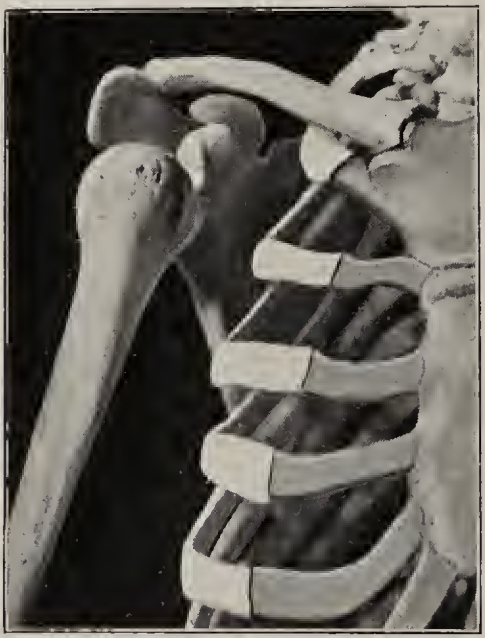

Fig. 687.—Axillary Dislocation of the Humerus.

Other Forms of Dislocation of the Shoulder-joint.—A relatively frequent form of dislocation of the shoulder-joint is that known as the **axillary dislocation** (Fig. 687). This dislocation differs from the **subglenoid** form (Fig. 688) only in the fact that the capsule and the attached tendons are ruptured to a greater extent. In that case the head comes to lie farther down against the infraglenoid tubercle, whence it may be drawn still farther downward by the latissimus dorsi and pectoralis major muscles.

The symptoms of axillary dislocation are essentially the same as those of the subcoracoid variety, with the exception that the head is lower down and can be felt in the axilla. Jössel found in a dissection of axillary dislocation a fracture of the greater tuberosity, a complication likewise observed in some cases of subcoracoid dislocations. The reduction of this form of dislocation is effected in the same manner as in a subcoracoid dislocation. It may also be reduced after the old method of Avicenna, namely, by grasping the head directly with the fingers and reducing it into the glenoid cavity.

The rarest variety of the superabduction dislocation is that known as the **erect dislocation** (luxatio erecta, Fig. 689), in which there is extensive rupture of the capsule and total separation of all the tendons from the tuberosities (Middeldorpf). The head not only passes into the axillary cavity but is forced still more deeply against the lateral thoracic wall.

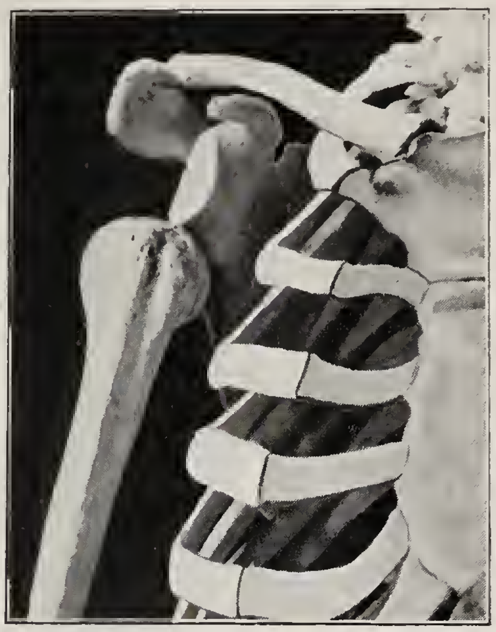
Fig. 688.—Subglenoid Dislocation of the Humerus.

While the great majority of dislocations of the shoulder-joint result from movements of superabduction, and this for the reason that the head of the bone, by this movement, is brought to bear against the weak inner and lower portions of the joint capsule and not against portions of the capsule reinforced by the supraspinatus, infraspinatus, and teres minor muscles, still, dislocations due to superadduction do occur. If the arm is adducted forcibly over the anterior surface of the thorax, the head is forced against the external capsular wall, and, after rupture of the capsule and tendon, may invade the infraspinous fossa, this constituting a **retroglenoid dislocation.** In this form the arm is slightly abducted and the head is to be found behind the external edge of the joint surface, with a depression formed under the acromion. The entire shoulder gives the impression of having been forced backward (Fig. 690). This dislocation is caused by a fall on the point of the shoulder, a fall on the outstretched hand with the arm in adduction, or a fall on the elbow with the arm flexed across the front of the chest. The reduction is effected by bringing the extended arm to superabduction and then reducing by pressure on the head. There is a tendency to recurrence in this form of dislocation. This dislocation sometimes occurs during an attempt at reduction of a subcoracoid dislocation, the head slipping beyond the lower edge of the glenoid cavity.

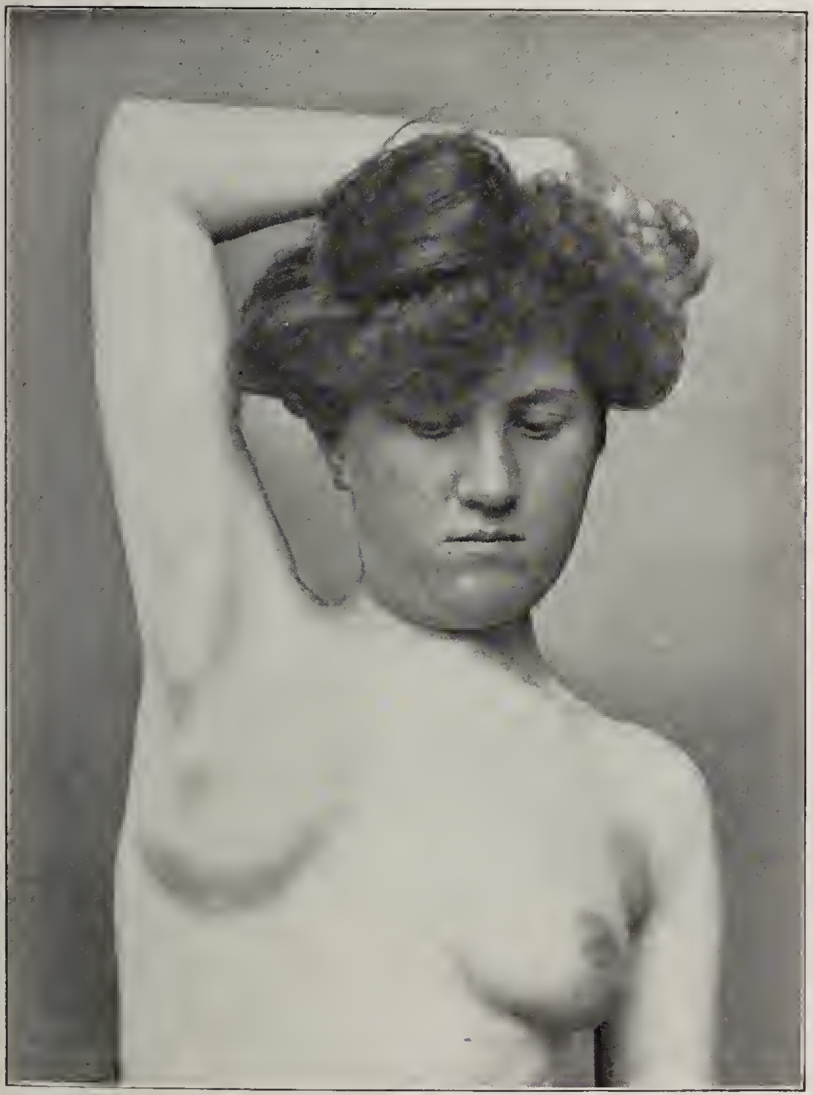
Fig. 689.—Erect Dislocation of Humerus.

A true **subacromial** or **supraglenoid** dislocation cannot occur for the reason that there is not sufficient room between the acromion and the upper edge of the glenoid fossa. The head of the bone can be forced in this direction only after fracture of the acromion or the coracoid, with rupture of the tendon of the subscapularis muscle and tearing of the anterior portion of the capsule.

A supracoracoid dislocation can occur only after fracture of the coracoid or acromion process.

Congenital dislocations of the shoulder-joint resemble those of the hip-joint, but are much less frequent. They are more frequently of the subcoracoid variety. An abnormally small glenoid cavity is formed on the anterior surface of the scapula below the coracoid process, in which the somewhat deformed head rests insecurely. Reduction has been attempted without success. An operative attempt to secure a better bearing for the head of the bone might be made, were it not for the marked atrophy of the muscles which usually exists in these cases.

Old Dislocations of the Shoulder.—An **unreduced dislocation** causes severe disturbances of function. A pseudarthrosis with relative mobility may develop as the result of methodic passive and active movements, but the full normal functions are not restored. The attempt should be made, even after the lapse of months, to restore the head to the glenoid cavity; this failing, it should be placed as near thereto as possible.

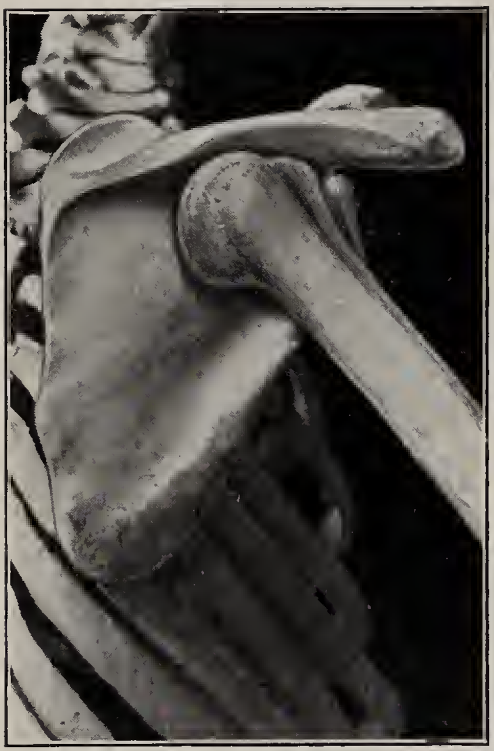

Fig. 690.—Retroglenoid Dislocation.

The persistent pressure of the dislocated head against the large vessels, specially the nerves, gives rise to formication or lancinating pains. Paresis or paralysis, and atrophy of the muscles may result. With the failure of attempts at reduction **resection** through an anterior incision, or one in the axilla, may be performed in these cases.

Habitual dislocation is that condition in which, perhaps a long time after the original injury and proper reduction, dislocation occurs on slight provocation, such, for instance, as slipping the arm in a sleeve, sudden abduction of the arm, etc. The accident may happen to both shoulders. Hueter saw two such cases in pregnant women, the dislocations occurring during epileptiform convulsions. Malgaigne suggested that habitual dislocation depended on increased width of the capsule, the tear in which had healed with a wide cicatrix. This was supported by Jössel by postmortem examinations in nine cases of this condition, in which it was found that the capsule was so spacious and relaxed that the joint head could leave the glenoid cavity and rest beneath the coracoid with the capsule not even greatly stretched. In all these cases the supraspinatus and infraspinatus muscles had been separated from the greater tuberosity, and the tendons of these muscles, which had receded behind the acromion, had drawn with them the attached capsule.

The treatment of habitual dislocation consists in the wearing of an apparatus to prevent superabduction, since it is in this position the accident occurs. Ricard operated successfully in two cases by narrowing the capsule by a pursestring suture of silk and immobilizing the joint for about five weeks. Finally, as a last resort, resection should be resorted to.

Fracture of the Greater Tuberosity.—Fracture of the greater tuberosity of the humerus is a not very rare complication of subcoracoid dislocation. It arises from the same mechanism as dislocation; the so-called **"distortion of the shoulder-joint"** in which a rent in the capsule and a hemarthrosis show that a dislocation, followed by a favorable secondary movement, has resulted in a spontaneous reduction, occurs. In fact, fracture of the greater tuberosity is sometimes accompanied by distortion. If the anatomic neck of the humerus impinges against the head of the glenoid cavity the greater tuberosity may be broken off, the dislocation occurring as well. This complication is recognized partly by crepitation and partly by sensitiveness in the region of the greater tuberosity. If recognized, the arm and shoulder should be kept immobilized for three or four weeks after reduction to avoid excessive callus formation and partial ankylosis.

Dislocation of the long head of the biceps sometimes occurs in connection with dislocation of the head of the humerus and fracture of the greater tuberosity, the tendon leaving its sulcus and becoming entangled with the neck of the humerus, thus increasing the difficulties of reduction.

Fracture of the Dislocated Head at the Surgical Neck.—This is probably the result of a powerful secondary movement which forces the head beneath the coracoid process after dislocation of the head takes place. In the presence of this complication the attempt may be made to approach the head to the glenoid cavity by traction on the arm in a manner similar to Allis's plan in the hip, where an attempt is made to manipulate the head into the socket (see page 502). This method of reduction is possible if the two fragments are held together by periosteum and muscle. McBurney's method consists in fixing the scapula with a hook through an open incision, another hook in the humerus pulling the head in place. If reduction fails by these means, resection is the only resource.

Fracture of the Neck of the Humerus.—This may occur at any age; its mechanism is similar to dislocations of the head of the humerus, the fracture taking place instead of a rupture of the capsule. In another group of cases a push or a blow against the outer surface of the shoulder produces the fracture. The line of separation usually lies below the tuberosities, where these grow thinner to join the shaft, *i. e.*, at the **surgical neck of the humerus.**

The **symptoms** resemble at first glance those of subcoracoid dislocation. The shaft approaches the thorax, as in case of dislocation, only careful examination revealing the presence of the head in the glenoid cavity. Crepitus, when this can be made out, at once calls attention to the true condition, but this is frequently absent, particularly in children, in whom the separation takes place on the epiphysial line (**diastasis of the upper epiphysis of the humerus**). Crepitation is likewise present in dislocation and simultaneous fracture of the greater tuberosity. In doubtful cases measurements of the two arms from the acromion to the external epicondyle of the humerus at the elbow will show a shortening in cases of fracture, while in dislocation there is, as a rule, a lengthening.

Still greater difficulties of differential diagnosis are met with when the question of fracture and dislocation arises in case of possible **fracture of the anatomic neck of the humerus.** This is observed less frequently, and occurs almost exclusively in old persons.

Fracture of the Humerus During Birth.—In breech deliveries, when the arm is elevated behind the head and while this is being disengaged, fracture of the humerus may occur. Separation of the upper epiphysis occurs more frequently than fracture of the shaft. Paresis and atrophy of the muscles, as well as retardation of the growth of the bone, often result. Disturbances of function in the muscles also arise from unavoidable contusions of the nerves of the arm during difficult deliveries.

Treatment of Fractures of the Neck of the Humerus.—In favorable cases there is **impaction** of the shaft into the soft spongy head of the humerus. Here, as in some other cases, reduction is not necessary. A modified Velpeau bandage is made to include the shoulder, arm, forearm, and chest. It is better to place the hand of the injured arm below the level of the nipple and in women below the mamma. Cotton must be plentifully applied between the arm and the chest wall. Or a plaster-of-Paris spica including the shoulder, the upper part of the chest, and the entire upper extremity except the hand, may be employed (Brewer). To prevent shortening extension is kept up during the application of the spica and until the plaster-of-Paris is hardened by making traction on two strips of adhesive plaster applied longitudinally to the arm. The parts beneath the apparatus are protected by several layers of sheet wadding (Fig. 692). If reduction cannot be maintained otherwise, the fragments may be exposed by incision and fastened together.

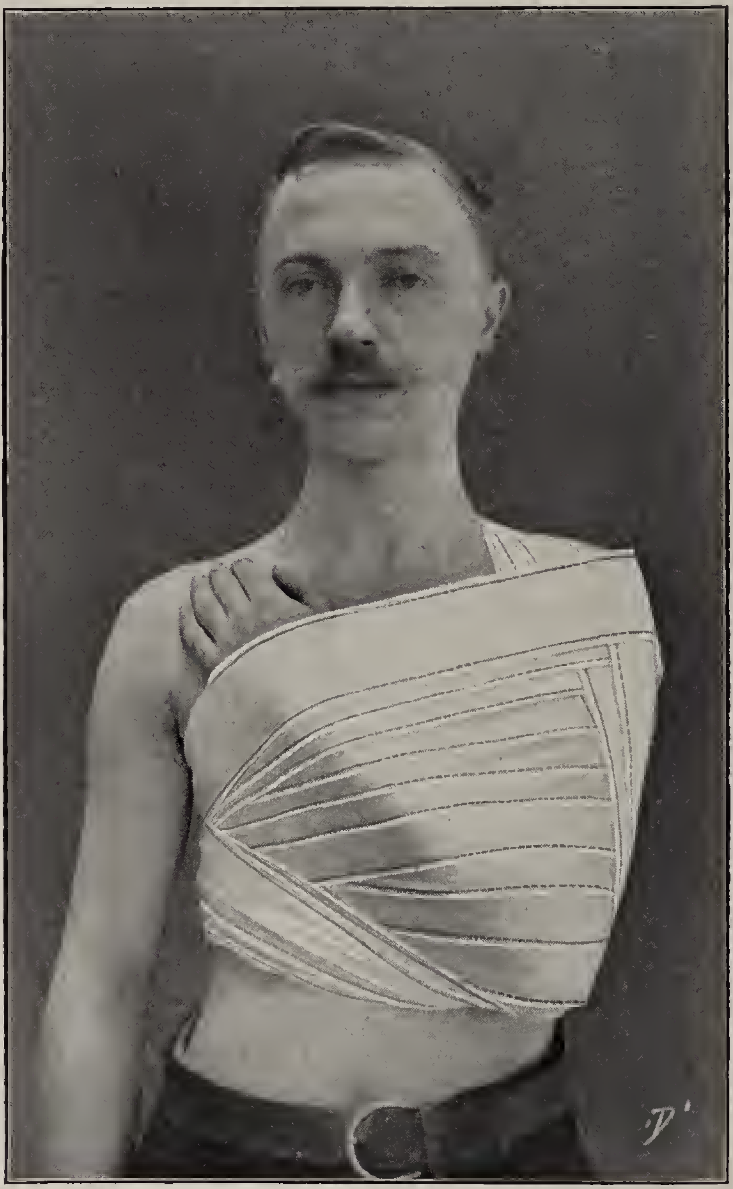

Fig. 691.—Velpeau Bandage.

Partial ankylosis always results after fracture of the neck of the humerus. This is to be treated by means of passive movements, massage, and warm baths, Atrophy of the muscles of the shoulder requires applications of electricity. In very rare cases **total ankylosis** may ensue, requiring **resection.** Failure of union may occur, particularly in elderly persons with fracture of the anatomic neck.

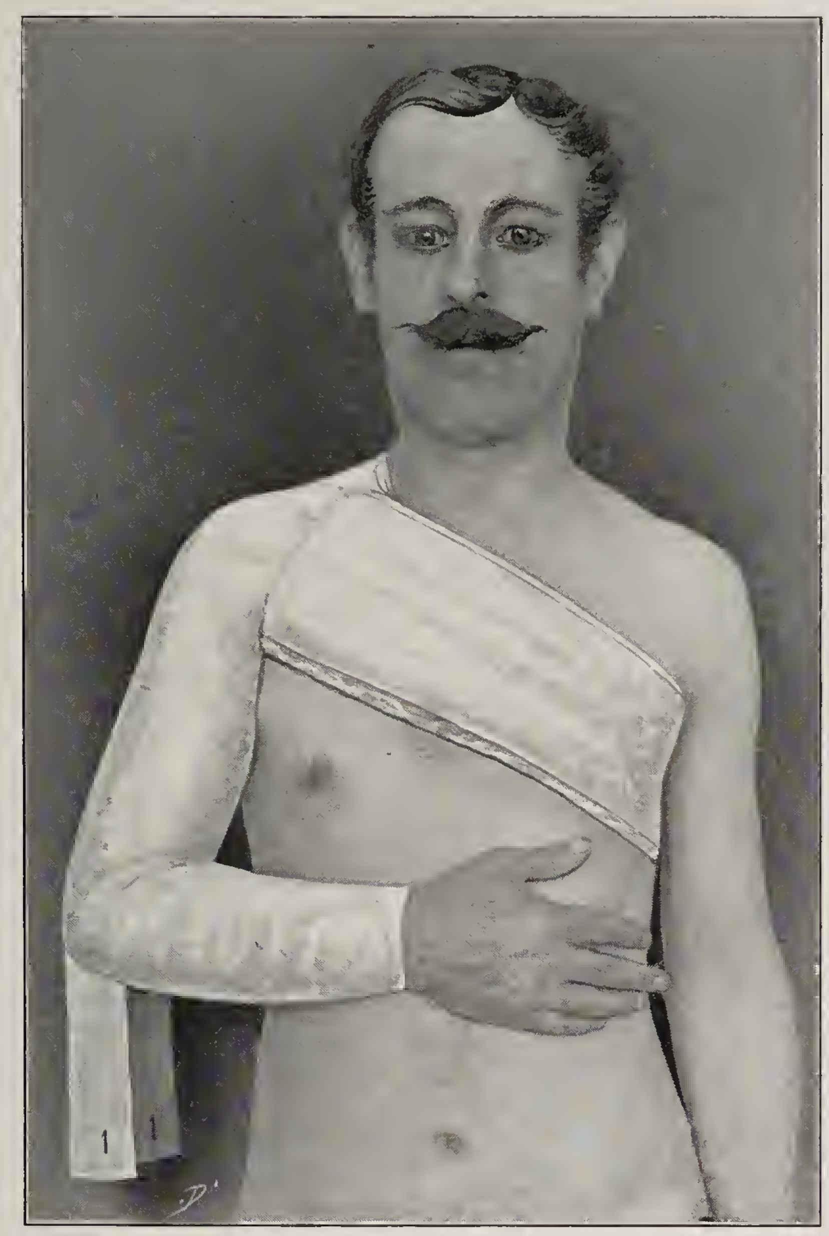

Fig. 692.—Brewer's Apparatus for the Treatment of Fracture of the Humerus. The strips of adhesive plaster by means of which extension is kept up during the application of the spica and while the plaster-of-Paris is hardening are shown at 1, 1.

INFLAMMATION OF THE SHOULDER-JOINT

Of all the large joints of the extremities, the shoulder-joint is the least disposed to inflammation (4.6 per cent in 896 cases, Hueter). It is not even frequently affected in polyarthritis. **Serous and fibrinous inflammations** of the shoulder-joint are followed by the growth of more or less intra-articular adventitious connective tissue, these seriously impairing the movements of the joint. Acute serous effusions result from sprains or contusions. On account of the peculiar environment of the shoulder-joint, with its thick muscular coverings and deep situation, distention of the capsule can rarely be made out. Exceptionally, when there is atrophy of the muscles and relaxation of the ligaments, the signs of effusion in the axilla or at the bicipital groove can be made out. Fluctuating swellings in the region of the deltoid and at the dorsum, or beneath the acromion, are due to involvement of the corresponding bursae (subdeltoid and subacromial bursae). The acute infectious diseases, as well as infection arising from pyemia and sepsis, may result in a serous or a fibrinous inflammation. When this results from chronic rheumatism, changes due to the productive form of inflammation (thickening of the capsule, etc.) occur, leading to the formation of adhesions between the joint surfaces. Or, true or bony ankylosis may finally take place. The **symptoms** relate chiefly to impairment of function of the joint. The movements of abduction and rotation are specially painful. Later, the space between the acromion and the head of the humerus is increased by the lowering of the arm through relaxation of the ligaments, and a depression is felt at this point. The presence of villous growths within the joint may give rise to fine crepitus.

The **treatment** of serofibrinous and fibrinous arthritis of the shoulder-joint consists in immobilization and the application of an ice-bag, the careful use of massage, and, later on, systematic passive movements to prevent ankylosis. In obstinate cases the joint may be irrigated with a 3 per cent solution of carbolic acid, or a 1 : 5000 solution of mercuric chlorid (Schede). In the chronic cases hot-air baths (Krause), massage, and passive movements are useful.

Suppurative Arthritis of the Shoulder-joint.—This is usually the result of either combined injury and infection, acute osteomyelitis, or metastasis occurring in the course of pyemia, variola, puerperal fever, scarlet fever, or typhus. It is accompanied by the usual symptoms of suppurative inflammation of a joint, namely, severe pain, high temperature, swelling more or less marked, and pronounced functional disturbance. The capsule is perforated and the periarticular structures become involved. The joint surfaces are destroyed and fine crepitus ("joint crepitus") is felt on motion. Before perforation of the capsule occurs the presence of pus may sometimes be made out by fluctuation at the borders of the deltoid muscle. The pus finally finds its way to the surface in the direction of least resistance, pointing at the margins of the deltoid, along the biceps, or in the axilla. Extensive burrowing of the periarticular abscesses may occur, these finally reaching the surface about the scapular region, the thorax, and on the arm, leaving fistulous openings. The **functional prognosis** is unfavorable, even in mild infections. Impairment of the movements of the joint almost always follows, in spite of every care. In metastatic suppuration the unfavorable prognosis of the general infection overshadows that of the local lesion for the time being, when the shoulder is but one of several joints involved. When the shoulder is alone involved, this bespeaks a lessened virulence, as regards both the general and the local infection.

Treatment.—Early evacuation of the pus is indicated in suppurative inflammation of the shoulder-joint. In mild infections subcutaneous puncture should be practised. If the fluid obtained is only slightly turbid (the so-called catarrhal suppuration), the joint should be irrigated with a saline solution, followed by a 3 per cent solution of carbolic acid or a 1 : 5000 solution of mercuric chlorid. Otherwise, or if this does not afford relief, a free opening should be made behind and below the joint, and tube drainage instituted. Finally, resection may be necessary, in order to secure competent drainage.

Extensive and intractable suppuration of the soft parts may necessitate amputation at the shoulder, or even interscapulothoracic amputation.

Gonorrheal arthritis of the shoulder-joint has been observed. It more frequently takes the form of the serofibrinous inflammation than of the suppurative. When suppurative inflammation of gonorrheal origin occurs, it is mild in character; destructive effects, such as are observed in phlegmonous inflammation, are rarely observed.

The joint affection is acute in its onset, resembling acute articular rheumatism, and may develop at any stage of the gonorrhea. The functional prognosis should be guardedly stated; in some instances considerable interference with mobility remains.

The **treatment** in the milder cases consists in the same measures employed in serofibrinous arthritis of this articulation; in the suppurative cases the treatment already laid down for that condition is to be followed (*vide supra*). The influence of specific remedies is probably *nil*. Good results have been claimed, however, from the use of potassium iodid. Schede's method of joint irrigation may be used, a 1 per cent solution of protargol being substituted for the carbolic acid solution. Bier's method of passive congestion may be useful. It is difficult to apply this to the shoulder, however.

Tuberculosis of the Shoulder-joint.—This is a comparatively rare affection, this joint apparently possessing greater immunity from tuberculous arthritis than all other joints of the body (1.4 per cent in 1996 cases, Billroth; other observers, however, place the proportion much higher). Its occurrence is not confined to the years of childhood. It is not common under the age of fourteen and has been observed as late as the thirtieth year. In some instances thickening and infiltration of the entire serous membrane occur (fungous arthritis).

The pathologic changes vary. The primary synovial form may consist of isolated nodular deposits on the free surface of the membrane; or more frequently this form is represented by diffuse invasion of the synovial membrane with tuberculous nodules.

The presence of considerable fluid in the joint is not necessarily a marked feature of the disease. When fluid is present, it may be a simple or somewhat cloudy serous effusion, or of a decidedly purulent character. More or less fibrin may be present.

Caries sicca is a name given to a peculiar condition of the joint consisting of a primary tuberculous osteoarthritis of the head of the humerus with rapid atrophy of this part of the bone, and hyperplastic synovitis. This rapid atrophy of the osseous tissues is unique in the pathology of joint disease, the preceding true inflammatory processes of proliferation of the medullary substance passing without recognition. In addition, the muscles surrounding the head of the humerus undergo secondary atrophy more rapidly than at any other joint. This atrophy is more quickly noticeable at the shoulder than elsewhere, for the reason that the contour of this joint is more largely made up of muscular structures than are those of other joints. Despite the absence of inflammatory swelling, intense neuralgic pains are felt in the arm, with slight, and often with no movements whatever. Postmortem examination in cases of caries sicca shows, besides atrophy of the head of the bone, an almost total absence of its medulla, with inflammatory adhesions between the synovial lining of the capsule and the articular surfaces. The affection is most frequently mistaken for rheumatism, a neurosis, or traumatism.

Though suppuration of the joint very seldom occurs in this variety of inflammation, yet the affection eventually obliterates the joint and leads to rapid atrophy of its muscles. In **caries fungosa** enormous masses of granulation tissue filled with tubercles proliferate in the spongy bone, replacing the latter, and, in some instances, extending into the medulla.

If the process is localized, the **vital prognosis** in tuberculosis of the shoulder joint is favorable, the supervention of prolonged suppuration and its common sequence, amyloid degeneration, alone endangering life. The **functional prognosis** is not so favorable. A slight loss of mobility greatly impairs the use of the entire extremity. The weight of the arm leads to ankylosis in an adducted position which excludes quite a large number of movements of the arm, though the muscular power of the elbow, hand, and fingers remains intact. In cases in which there is softening of the ligamentous structures about the joint, this, together with the muscular atrophy, permits the head of the bone to be drawn away from the socket and a loose joint or "flail arm" results. The arm, under these circumstances, though movable, is of less use to the patient than if ankylosed, since the muscular power is practically *nil*, and the arm cannot be made sufficiently rigid to make proper use of the forearm.

The disease is often accompanied by tuberculosis of other organs, particularly the lungs, in which case recovery from the joint affection is not to be expected.

Treatment.—Immobilization and the injection of iodoform emulsion constitute the measures of treatment at the commencement of the disease. The weight of the arm and the use of a simple sling may effect immobilization sufficiently well. Should a retention bandage seem necessary a Velpeau bandage (Fig. 691) may be applied. Bier's method of passive congestion may be useful, if it can be applied. Resection of the joint is an important measure of treatment, for the purpose of removal of the disease and of drainage, as well as for the preservation of function, and, when this is greatly impaired, for its improvement. Extensive involvement of the soft parts may demand amputation.

Arthritis deformans occurs not infrequently in the shoulder-joint. The occurrence of the affection in this locality, as elsewhere, seems to bear some relation to hard labor and an outdoor life combined. Traumatisms more severe than those which occur in ordinary laborers, such as sprains, contusions, dislocations, and fractures extending into the joint, are responsible for the inflammation in some cases.

The degenerative changes in cartilage and bone, characteristic of the disease elsewhere, are found in the shoulder-joint (see page 152, Vol. I). Alterations in shape occur, both in the head of the humerus and in the glenoid cavity; the former is enlarged from productive inflammation, while the latter is irregularly broadened from regressive changes. The head of the bone may be displaced downward from relaxation of the ligaments and the weight of the arm, or in an upward direction from the shortening of the capsule and the tendon of the supraspinatus. The synovial membrane is studded with villi and the capsule is thickened. The joint may contain more or less serous effusion. Unlike other affections of joints in which hyperplastic processes prevail in the pathologico-anatomic picture, true ankylosis never obtains in arthritis deformans. The progress of the disease steadily tends to further destruction.

Treatment.—A course with the combined douche and massage treatment at Aix-les-Bains, or the "fangho" or mud applications at Salsomaggiore, Italy, may prove useful. The production of hyperemia by means of hot-air baths, active inunctions, etc., and of passive congestion by means of elastic circular compression applied above the joint (Bier) may be tried. Electricity may be employed for atrophy of the muscles. The question of operative interference will depend on the age of the patient and the presence or absence of disease of the other joints. In large effusions the joint should be irrigated with an antiseptic solution (Schede) (see page 371, Vol. I). Severe monarticular disease in young persons will justify erasion or even resection.

Neuropathic Arthritis of the Shoulder-joint.—This occurs in the course of certain diseases of the central nervous system, particularly syringomyelia, either alone or in connection with other joints. Trauma may precede its occurrence or provoke a more rapid development of the disease. The changes in the joint are practically identical with those of arthritis deformans, but the growth and the destruction of bone occur to a much greater extent. In the **hypertrophic form** the predominating features are the thickening of the articular surfaces and the marginal structures, and the growth of villi and osteophytes. The latter may extend to the shaft of the humerus and occur even in the adjoining muscles. In the more frequently present atrophic form atrophy of the joint structures occurs. In this form the joint becomes easily dislocated; extreme displacement may occur. The effusion may be slight, or a marked hydrarthrosis involving the subdeltoid bursa may be present.

Symptoms.—Attacks or crises of pain may precede the development of the joint affection. The striking characteristics of the disease, however, are the presence of a deformity, of multiple painless whitlows (**panaris analgicum** or **Morvan's disease**) and resulting mutilations of the fingers, and the absence of pain. The ability to use the member, in view of the deformity present, is surprisingly good in the absence of paralyses or the disabling effects of the panaritia. Suppuration and perforation of the joint may occur.

The **diagnosis** rests on the painless character of the joint lesion and the presence of the deformity of the shoulder. These symptoms, occurring in connection with the evidences of central disease of the nervous system suggestive of syringomyelia (analgesia and abolition of the temperature sense, atrophic paralyses, etc.), will verify the diagnosis. The shoulder-joint disease rarely occurs in connection with tabes, the joints of the lower extremity becoming more frequently affected in the latter disease.

The **treatment** is usually limited to the use of apparatus to protect the joint and to prevent dislocation. Resection, or even amputation, may be demanded by persistent or intractable suppuration.

Inflammation of the Soft Parts Near the Shoulder-joint.—**Simple abscesses** of the connective tissue on the anterior surface of the shoulder sometimes follow contusions. **Pyemic abscesses** occur in the subdeltoid and subacromial bursae, particularly the former, which may simulate inflammation of the shoulder-joint. **Acute subdeltoid bursitis** may occur spontaneously. **Ricelike bodies** have been found in this bursa mucosa.

Inflammation and suppuration adjacent to the joint capsule may follow fracture of the coracoid process. The **subcoracoid bursa** may then be affected also.

Chronic inflammatory conditions in the bursalike spaces between the serratus magnus and the subscapularis, or between the former and the chest wall, sometimes cause a peculiar friction as the scapula is moved (**scapular crepitation**).

Suppurative inflammation at the lower portion of the shoulder-joint has its origin almost exclusively in **axillary lymphadenitis,** which latter is caused, as a rule, by infectious processes occurring in the region of the fingers and hand. The original wounds in these cases are insignificant, and may have healed before the infection, which in the meanwhile has reached the lymph-glands, manifests itself. This infection of the axillary lymph-glands is occasionally, though rarely, due to mastitis. Superficial abscesses arising from **infection of the sweat-glands** in the axilla are sometimes observed in weak and anemic individuals. These occur in "crops," like furuncles elsewhere.

The so-called **rheumatic shoulder** consists of a subacute and chronic inflammation of the fibrous structures at the acromioclavicular articulation. It occurs in individuals with the so-called "lithemic" diathesis. The exciting cause is long-continued pressure, as, for instance, a tight suspender. Sleeping on the side with the weight of the trunk on the shoulder will also produce it. There is pain radiating down the arm and in the scapular region, and inability to perform certain movements. The sheath of the deltoid sometimes takes part in the affection. A friction sensation and sometimes an audible friction sound is heard when certain movements are made. The **treatment** consists in removal of the cause, and the use of massage and passive movements to increase the nutrition of the parts, promote absorption of inflammatory exudates, and break up adhesions. Rapidly alternating hot and cold douches are useful.

TUMORS OF THE SHOULDER REGION

Such benign tumors as **hygromas of the bursae mucosae** and **lipomas** are frequently found in the soft parts of the shoulder and its neighborhood. Much more rarely **capillary angiomas, pigmented nevi,** and fibromas are found.

Hygromas of bursae are most frequently due to pressure on the acromion and the acromial end of the clavicle, occurring in those who carry heavy weights on the shoulder. **Accidental bursae mucosae** develop in which a serosynovial fluid accumulates. Puncture and the injection of tincture of iodin usually suffice for the cure. If recurrence takes place, or in case the bursa is an old one, extirpation should be practised.

Ossification in the subcutaneous connective tissue of the region of the acromion and deltoid muscle was described by Dupuytren as occurring in soldiers from the rebound of the old-fashioned pieces in firing. Similar conditions have been observed in other muscles from overexertion.

The region extending from the supraclavicular fossa to the posterior edge of the scapula and downward to and beyond the region of the insertion of the deltoid is frequently the site of the growth of **lipomas.** Adult women are more frequently affected than men. The majority develop in the acromial region. These tumors are of slow growth and sometimes attain enormous size. They become troublesome from their size and weight. Occasionally ulceration occurs and at times suppuration from infection extending from the sebaceous glands of the greatly attenuated skin, particularly in old persons. Pains are sometimes felt in the nerve distribution, and **paresis of the muscles** of the extremity, which extends to the fingers and is due to pressure, is observed. These symptoms disappear on extirpation of the lipoma.

In the **treatment of these tumors by extirpation** care should be taken to remove the skin overlying the most prominent portion of the growth, for the reason that this is so attenuated as to become necrotic and invite infection. There is a peculiar tendency to infection of the wound after the removal of these growths; in preaseptic times erysipelas occurred frequently and was particularly dreaded. Recurrence is exceptional, though sarcoma has developed in the cicatrix after removal.

Sarcomas develop not infrequently about the shoulder, specially in the region of the deltoid and triceps. Their extirpation is almost invariably followed by recurrence. **Syphilomas** and **syphilitic myositis** of the biceps, followed by contraction of the elbow-joint, have been reported (P. Vogt). **Menstrual hematoma,** *i. e.*, a hematoma occurring periodically in connection with menstruation, has been observed (Pitha).

Secondary carcinoma is the form of tumor most often encountered in the axillary region. The axillary lymph-glands are almost invariably infected in cases of long-standing carcinoma of the breast; less frequently in carcinoma of the back of the hand. In addition, **sarcomas, simple lymphomas,** and **leukemic lymphomas** are not uncommon in the axillary region.

Sarcoma of the Humerus.—Of the bones of the upper extremity the humerus is most frequently attacked by sarcoma, the disease in this connection occurring at all ages and giving rise to a high mortality. Central sarcoma is the usual variety, affecting the upper end by preference; or periosteal sarcoma may involve the whole shaft.

On account of the impossibility of obtaining flaps free from the disease by less radical procedures (W. W. Keen, R. S. Fowler), large sarcomatous growths involving the soft parts in the neighborhood of the shoulder-joint and adjacent parts, as well as those **occupying any portion of the humerus,** require **amputation of the entire upper extremity (interscapulothoracic amputation)** (see page 440).

INJURIES OF THE LARGE VESSELS OF THE REGION OF THE SHOULDER

Injuries of the **subclavian artery** are comparatively rare, because of the protection afforded by the large pectoral muscle. In case of stab or gunshot wound of this vessel the danger of death from hemorrhage is imminent on account of the size of the artery and its proximity to the heart. Injuries of the branches of this vessel, particularly if these occur near their origin, are also dangerous. While the external bleeding may not be profuse, the blood, as it escapes from the vessel, is rapidly effused into the surrounding soft parts. The pressure from this source sometimes serves to hold the bleeding in check until surgical assistance can be obtained.

Provisional arrest of the hemorrhage may be effected by pressing the artery against the first rib with the fingers. Where this is difficult, as in a fat person, Syms proposed to make this pressure through an incision rapidly made for this purpose. **Excessive adduction** of the arm over the anterior chest wall, placing the hand of the injured side on the lateral chest wall and beneath the axilla of the opposite side, is often efficient as a provisional measure. The clavicle is thereby forced against the first rib and the artery compressed between the two bones.

Permanent arrest of the hemorrhage requires the application of a ligature. The application of a ligature between the coracoid process and the clavicle in Mohrenheim's fossa has been abandoned for ligation of the subclavian above the clavicle (see page 636, Vol. I).

The **axillary artery** may be injured by stab and gunshot wounds and also by dislocations of the shoulder. Of injuries of the axillary artery occurring in connection with this injury 40 per cent result from the dislocation itself and 60 per cent from attempts at reduction. Twenty-five per cent of the cases prove fatal from subsequent rupture of the resulting traumatic aneurism.

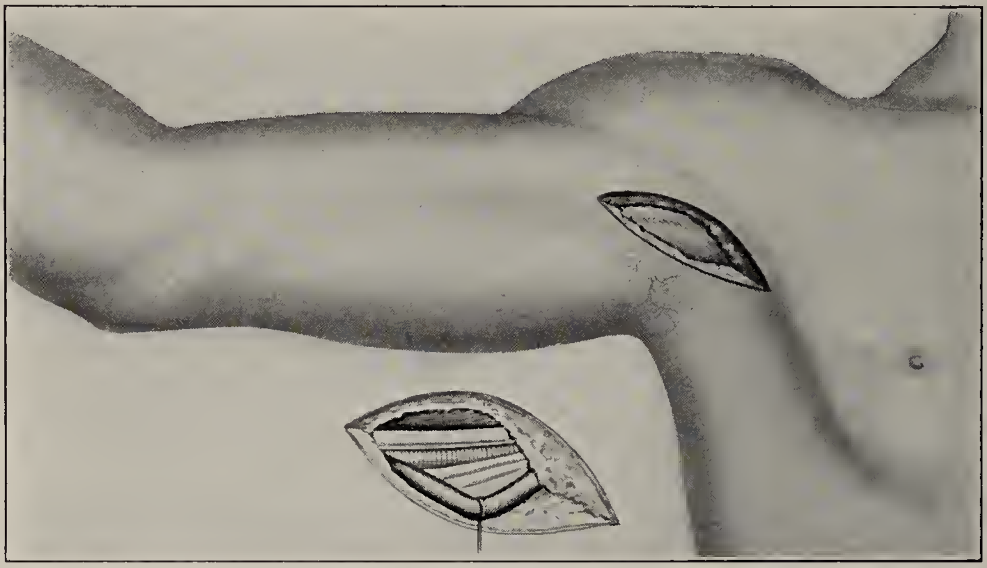

Fig. 693.—Ligation of Axillary Artery.

Operative injury of the axillary artery occurs during removal of secondary carcinomatous deposits in the lymph-glands of the axilla. If the glands cannot be removed without injury to the vessel, the latter should be tied both above and below. **Provisional ligation** of the subclavian below the lower edge of the pectoralis minor and coracoid process may be performed. In case of radical operation for carcinoma of the breast and removal of the pectoralis major muscle (Halsted) the artery is easy of access at this point.

Typic ligation of the axillary artery is indicated by hemorrhage from the arteries of the arm which cannot be controlled by local ligation or by ligation in continuity of the brachial artery. The operation is performed as follows (Fig. 693): The arm is abducted to a right angle and the hand supinated. The tense pectoralis major and latissimus dorsi muscles distinctly outline the limits of the axillary space. The head of the humerus is located and a three-inch incision made on the posterior edge of the pectoralis major muscle, commencing over the head of the humerus. In case the coracobrachialis cannot be identified, the surgeon places his three fingers in the axillary space between the pectoralis major and the latissimus dorsi and marks out the place for the incision between the finger anteriorly placed and the middle finger. After separating the fascia the muscular fibers of the coracobrachialis are sought for. The vein or veins, with the median nerve, may overlie the vessels. The vein is to be displaced to the inner and the nerve to the outer side, the artery is to be identified by its pulsation, and the aneurism needle passed around the artery from the ulnar to the radial side, below the circumflex branches. The artery is sometimes crossed by a muscular slip from the latissimus dorsi at this point.

Punctured wounds of the **subscapular artery** near its origin, the latter corresponding to the lower margin of the scapula near the glenoid cavity, may cause severe hemorrhage. Local ligation is here indicated.

Aneurism of the axillary artery, exclusive of traumatic aneurism consequent on dislocation of the humerus, already mentioned, also occurs. Of 75 of these cases treated by ligation of the subclavian artery, collected by Wyeth, 37 per cent proved fatal from secondary hemorrhage, gangrene of the arm, etc.

Operative injury of the axillary vein is unavoidable in some cases. It is a serious accident, not only from the loss of blood but because of the entrance of air into the vein. In small wounds of the vessel wall **lateral ligation** may be attempted; in larger ones, **double circular ligation,** one ligature being applied above and the other below the wound in the vein, should be performed. The return circulation is quickly reestablished through the cephalic vein.

Rupture of the axillary vein in connection with dislocations of the head of the humerus is not so frequent as injury of the artery. Of four such cases collected by Körte, three ended fatally. Ligation should follow the injury as quickly as possible.

RESECTION OF THE SHOULDER-JOINT

The indications for this operation are as follows: (1) traumatism; (2) inflammatory conditions involving destruction of the joint (tuberculous disease); (3) loss of function from ankylosis; (4) nonmalignant tumors of the upper portion of the humerus.

Of the traumatisms demanding resections gunshot wounds are the most frequent. When the head of the bone is splintered, primary resection is indicated. Secondary resection is indicated when suppuration supervenes on attempts to treat conservatively simple wounds involving the joint. Next in frequency come irreducible dislocations, with pressure on the vessels and nerves in the axilla, and dislocation complicated with fracture of the neck of the humerus in which reposition is impossible.

Resection is usually indicated in **caries sicca** in those under forty. The results of conservative treatment are unsatisfactory and ankylosis is the almost invariable rule.

In **partial** or **total ankylosis** the question will be decided according to the extent of impairment of function. Here the question of age also enters. The operation is not well borne by those beyond the age of forty and the functional results are not so good, owing to the lessened power of new bone formation on the part of the periosteum.

Methods of Operating.—Subperiosteal resection should always be performed when possible, in order to insure a movable joint, as well as to prevent the dropping of the arm which results from simple division of the attachments of the scapular muscles to the tuberosities of the humerus and capsule of the joint. The loss of attachments of these muscles also permits undue traction on the part of the pectorals and the latissimus dorsi muscle and the arm presents the appearance of an irreduced dislocation.

Langenbeck's Method (Fig. 694).—The incision extends from the anterior edge of the acromion vertically downward for from 2½ to 4 inches. The fibers of the deltoid are separated and the joint capsule reached. The sheath of the long head of the biceps is opened, the tendon followed into the joint, and the head of the bone exposed. The periosteum is now loosened from the inner surface of the neck of the humerus; a strong knife is applied to enlarge the opening in the capsule in a direction parallel to the inner edge of the bicipital groove and on a line with it. The periosteum is now carefully lifted, when the lesser tuberosity is reached. The attachments of the subscapularis muscle are separated closely on the bone, the connection of the fibrous joint capsule with the separated periosteum being also carefully preserved. As the separation advances toward the axillary cavity an assistant rotates the arm outward on its own axis. Both elevator and knife are necessary in separating the attached parts from the bone, particularly the synovial capsule. By elevating the arm and rotating it at the same time, the tendon of the biceps is lifted out of its sheath; in some cases it has to be sacrificed, particularly where it has been injured or is the seat of tuberculous disease. The periosteum, together with the three muscular insertions at the greater tuberosity, is now loosened at the external surface of the neck of the humerus by means of the elevator and knife. The head may now be dislocated and the capsular insertion separated from the posterior surface of the head by an incision carried directly upon and into the bone substance, in order to insure complete division. The elevator is again

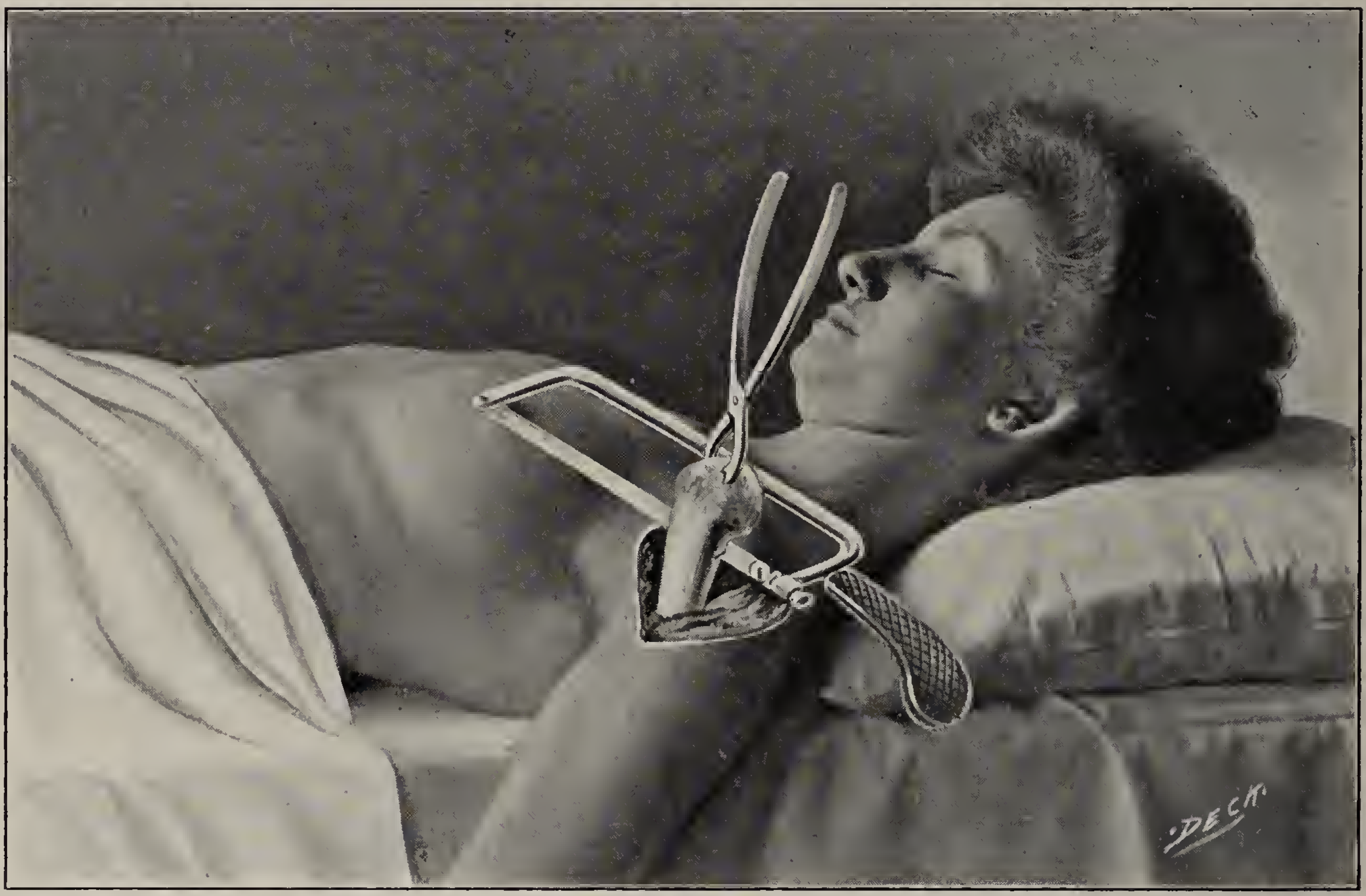

Fig. 694.—Langenbeck's Method of Resection of Shoulder-joint.

applied and the periosteum easily lifted at this point. The bone is sawed directly between the tuberosities.

Hueter's Method.—This is a modification of Langenbeck's, and consists in sawing across the surgical neck before loosening the periosteum and muscular attachments at the tuberosities. The soft parts and periosteum are separated from around the shaft of the humerus by means of a curved periosteal elevator, the bone is sawed across about half an inch below the surgical neck, the fragment grasped by strong forceps and rotated strongly

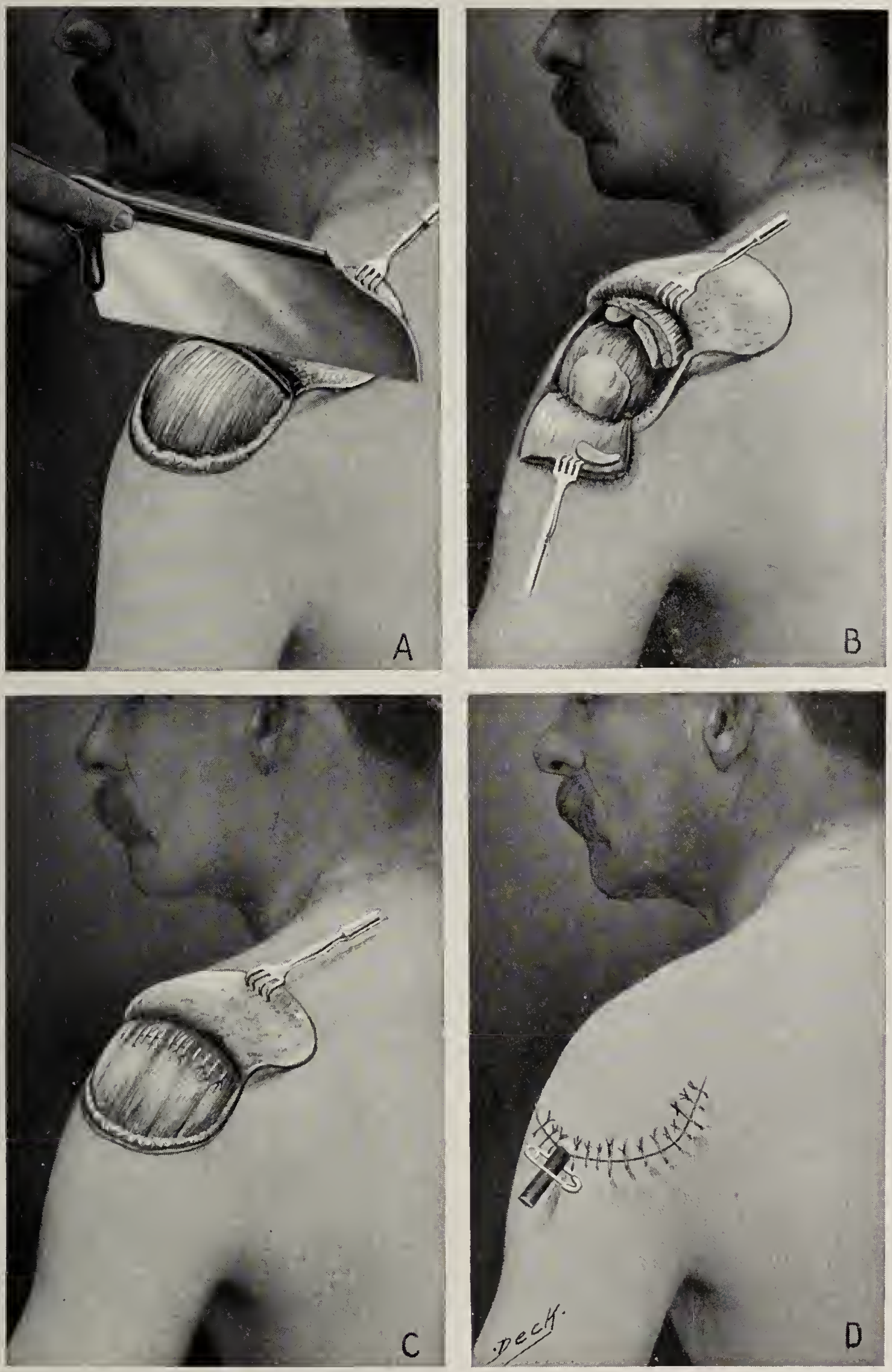

FIG. 695.—SENN'S METHOD OF RESECTION OF THE SHOULDER-JOINT.

A, The deltoid muscle exposed and incised transversely; the saw applied; B, the acromion divided and the flap reflected; C, the parts replaced and the muscle sutured; D, the skin sutured and the drainage-tube in position.

outward, and the periosteum separated on the inner surface until the joint capsule is reached. The latter is now separated at its inner and lower aspect, where it is free from tendons. The tuberosities with their muscular attachments are now detached subperiosteally.

Both the above methods require a longitudinal incision and consequently the circumflex nerve is divided. Resection through an anterior longitudinal incision sufficiently short to escape the nerve would be very difficult. To overcome these objections Ollier devised an incision extending from the outer border of the coracoid process in the direction of the fibers of the deltoid, obliquely and outward, a distance of four or five inches, to the shaft of the humerus (the anterior oblique incision).

Senn's operation is designed to avoid damage to important vessels, muscles, tendons, or nerves; good functional results are obtained. The external incision is made so as to form an oval cutaneous flap which exposes the upper portion of the deltoid muscle and gives access to the base of the acromion process. The incision commences over the coracoid process and terminates at the posterior border of the axillary space at a point on the same level as the commencement of the incision at the coracoid (Fig. 695). This flap is turned up, and the acromion sawed off and turned down with the attached deltoid. This gives access to the capsule, which is opened, and the head of the bone is exposed. After resection the acromion is replaced and held in place by sutures of catgut through the periosteum.

Limits of the Resection.—Extensive removal of bone is sometimes required in gunshot injuries. When this is possible it is always to be preferred to amputation. The removal of the entire humerus for gunshot injury has been followed by a useful hand, even though no new bone formed. The best results have occurred, however, when regeneration of bone has followed extensive necrosis and the removal of portions of the diseased bone as sequestra.

In the majority of cases the glenoid cavity is not disturbed in resection of the humerus; this portion of the articulation, as a rule, is but superficially affected, if at all.

After-treatment of Resection of the Humerus.—After the application of the usual aseptic dressings a pad of cotton is placed in the axilla to prevent inward displacement of the humerus, and the arm is bandaged to the chest. A fixation apparatus is not necessary. Later a simple sling is sufficient. Passive movements, including those which refer to all three axes of the arm, are to be commenced at the end of the fourth week and continued for a period of several months; active movements of first the fingers, later the hand, and finally the elbow, should be begun earlier. Active movements will be confined at first to those of flexion and extension. Owing to the impairment of the deltoid in Langenbeck's operation and its modifications, abduction will be the longest delayed. Ollier's method permits voluntary abduction at a much earlier period. The application of the interrupted current will be useful. Persistent efforts on the part of both surgeon and patient will frequently be followed by a most flattering success, as regards both appearance and function.

AMPUTATION AT THE SHOULDER-JOINT

The **indications** for amputation at the shoulder-joint include (1) sarcoma of the lower end of the humerus; (2) crush injuries reaching to the point of insertion of the deltoid; (3) advanced inflammatory disease of the joint, with extensive involvement of the extra-articular tissues. In the second group, amputation of the shaft of the humerus should be practised whenever possible as a conservative measure. The last group, under aseptic and antiseptic conditions, is greatly restricted, resection of the shoulder-joint largely replacing amputation.

The **operation** is performed in a bloodless manner by the use of Wyeth's pins to retain an elastic constrictor in position (Fig. 696). The first or anterior pin is entered just in front of the acromion process and at least an inch above the level of the glenoid cavity, passes between the neck of the scapula and the axillary vessels, and emerges at the middle of the lower margin of the anterior axillary fold. The second or posterior pin is entered a little above the spine of the scapula and on the same level as the first, hugs the posterior surface of the scapula closely, and emerges at a corresponding point on the posterior axillary fold. The rubber constriction is snugly applied above the pins (Fig. 696). A longitudinal incision is made from the anterior border of the acromion nearly to the lower limit of the deltoid. Two divergent skin incisions from the longitudinal incision meet behind. Skin flaps inclosed by these lines are dissected up rapidly, the assistant turning up the cuff from one side while the operator does the same from the other. With the flaps well retracted a circular sweep of the amputating knife divides all the muscular structures at the level of the upper limit of the joint capsule. The vessels are secured before the constric-

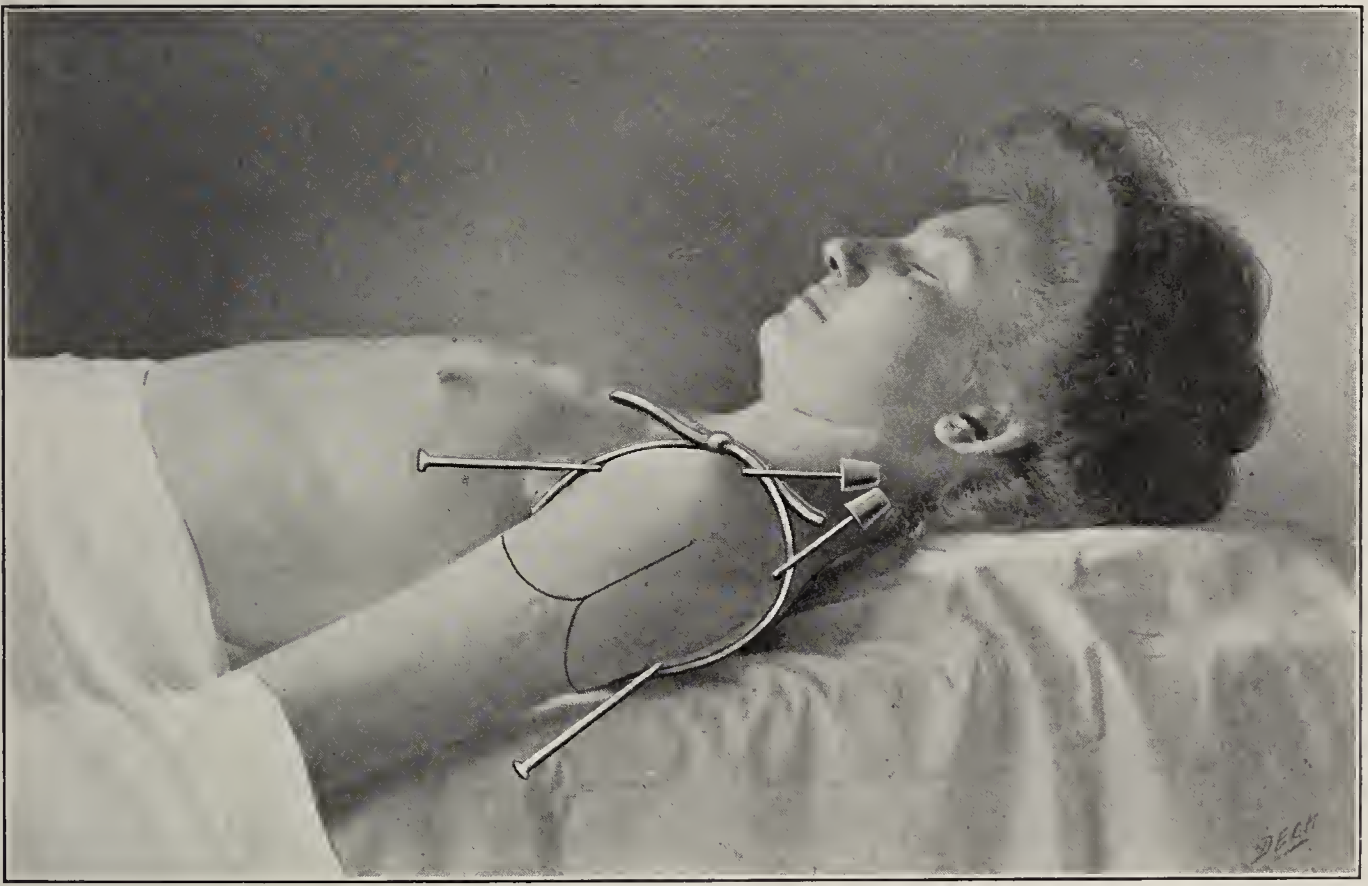
Fig. 696.—Shoulder-joint Amputation. Wyeth's Pins Retaining an Elastic Constrictor in Position.

tion is removed. The acromion may be sawed off to increase the cosmetic effect.

A suture that includes the entire thickness of the skin, the ends of which include the rubber constrictor when tied together, serves a good purpose in this connection. Several such sutures are placed on the circumference of the limb.

Preliminary ligation of the axillary artery or of the subclavian artery may be performed if Wyeth's pins or some substitute therefor (mattress needles) are not at hand. The attempt to use a constricting band without pins or some similar devices to prevent it from slipping is dangerous, and digital compression of the subclavian is not to be relied on.

Amputation of the Entire Upper Extremity (Paul Berger).—The removal of the entire upper extremity, including the humerus. the scapula and the outer two-thirds of the clavicle (Paul Berger), is not infrequently done in modern times with good results, according to statistics collected by R. S. Fowler.

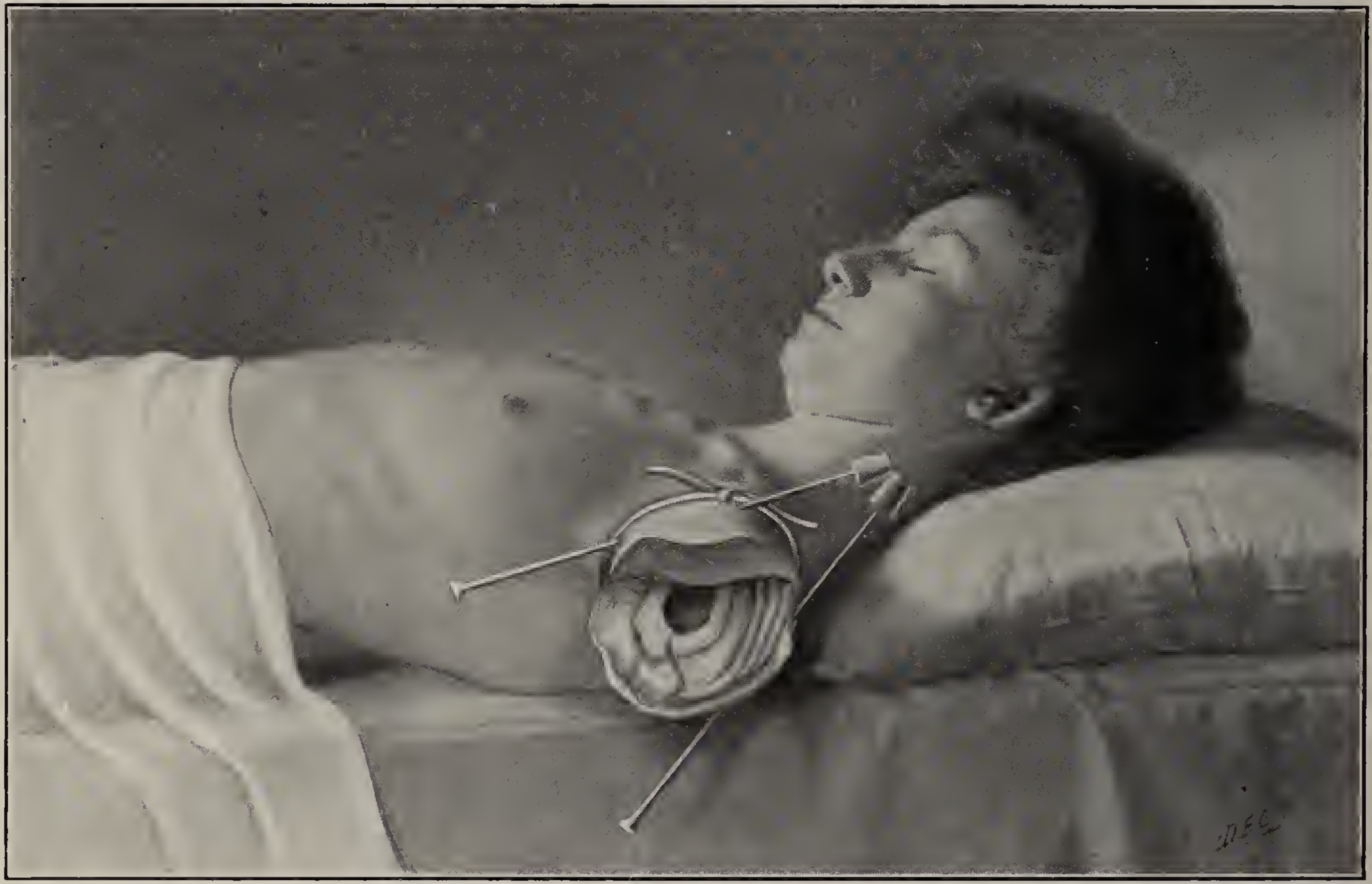

FIG. 697.—THE FLAPS AFTER SHOULDER-JOINT AMPUTATION.

Indications.—(1) Malignant tumors of the region of the shoulder or of any portion of the shaft or head of the humerus; (2) extensive infection of the soft parts in connection with disease of the shaft of the humerus or the shoulder-joint; (3) extensive injuries.

Operation.—The incisions employed will vary with the indications and the conditions present. Hemorrhage is to be controlled by preliminary ligation of the subclavian artery, which is best accomplished after resection of the middle third of the clavicle. An incision (Fig. 698) is made along the upper surface of the clavicle, the bone bared and the periosteum reflected. In thin patients the bone may be divided by a small amputating or keyhole saw; otherwise the Gigli wire saw or the chain saw must be used. The first section is made close to the outer attachment of the sternomastoid muscle, at the junction of the middle and outer third. The intervening portion is removed. The deep layer of the cervical fascia and the subclavius muscle is now divided and the vessels exposed. The artery is ligated first and then the vein. Two ligatures are applied to each and the vessels divided between.

The patient is now brought to the edge of the table and the arm held away from the body. The anterior incision is commenced at the middle of the clavicular incision, is carried downward and outward to the outer side of the coracoid process, passes parallel to the groove between the deltoid and the pectoralis major, crosses the lower margin of the latter muscle, thence passing across the axillary space to its posterior border. The arm is now raised and the incision continued downward and inward to the posterior surface of the scapula, from which point it is extended downward for a short distance between the muscular mass which comprises the latissimus dorsi and the teres major, and the vertebral border of the scapula (Fig. 698). An anterior skin flap is dissected up, the pectoralis major divided in a vertical direction well inside the line of the skin incision, and the pectoralis minor at its attachment to the coracoid process.

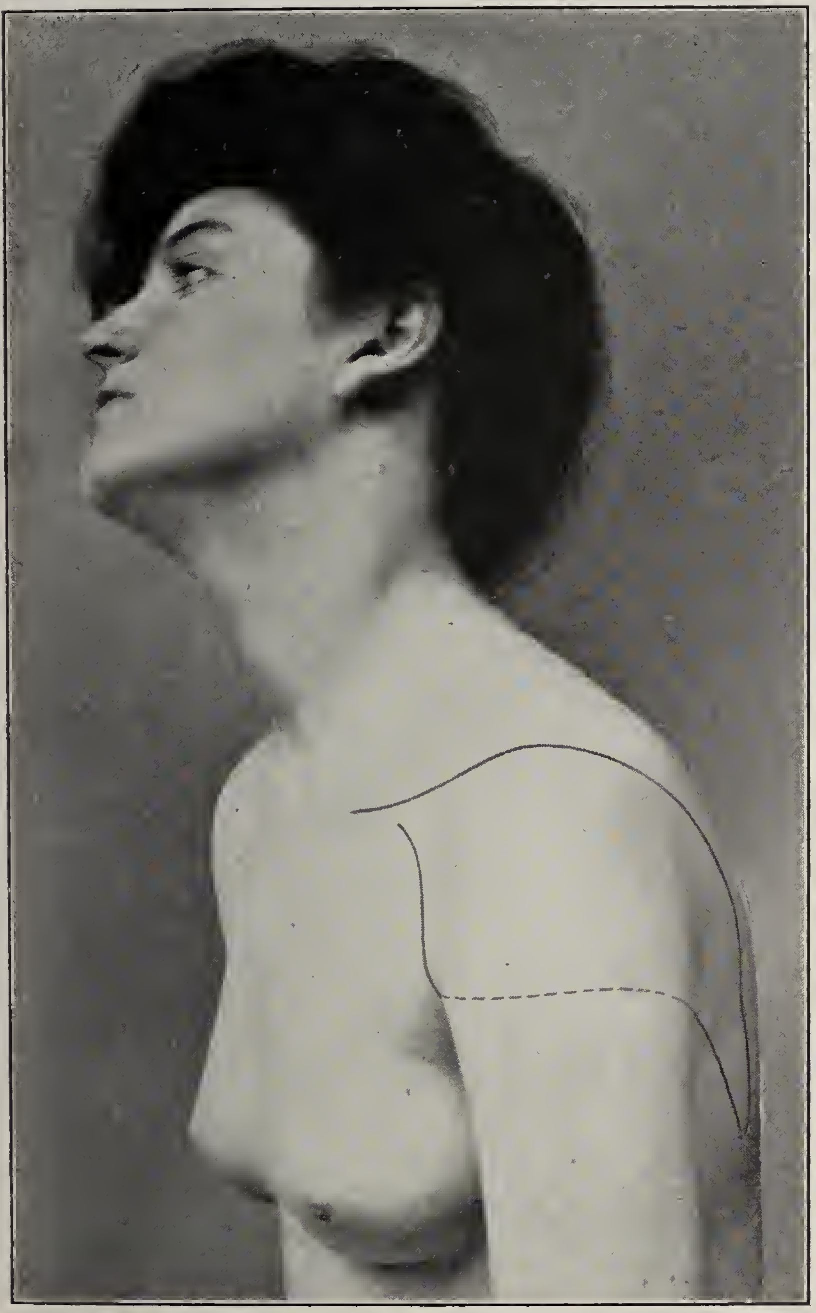

Fig. 698.—Amputation of Entire Upper Extremity.

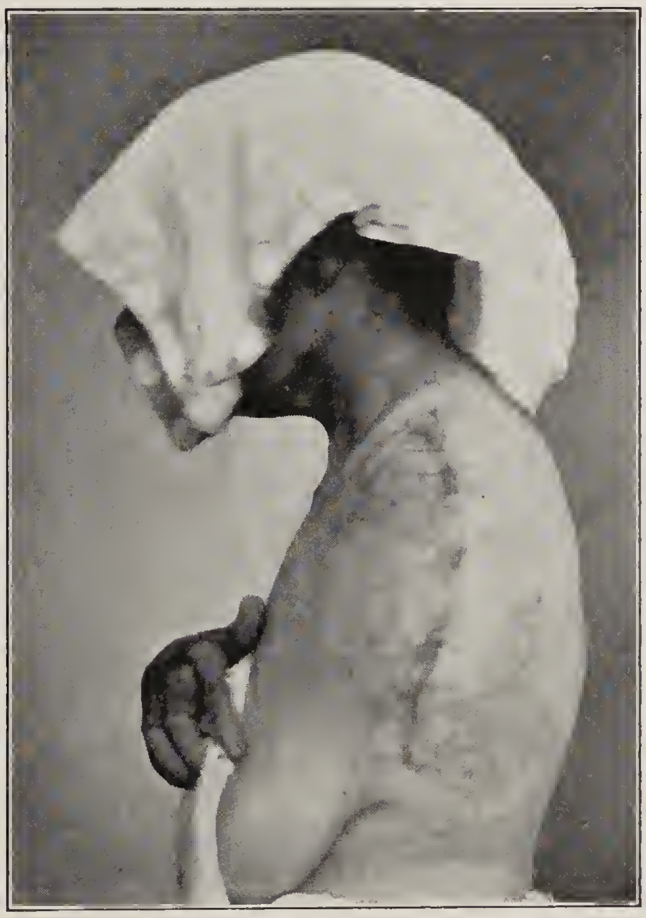

Fig. 699.—Appearance after Amputation of Upper Extremity.

The patient's arm is now thrown over the chest and the scapular region well exposed. The second incision commences at the outer termination of the clavicular incision and is carried with a slight outward curve to the termination of the first incision below the angle of the scapula. The posterior skin flap is dissected back and the clavicular and scapular attachments of the trapezius severed. The omohyoid, the levator anguli scapulae, the rhomboideus minor, the rhomboideus major, and the serratus magnus on the thoracic side of the vertebral border of the scapula are successively divided. The limb is now moved by an assistant so as to enable the operator to identify any remaining connections at this point. Finally, the latissimus dorsi is severed in the lower angle of the wound.

The large wound cavity is closed by buried sutures in the muscular substance and the skin edges united in the long axis of the oval opening.

THE ELBOW-JOINT, THE LOWER PORTION OF THE ARM, AND THE UPPER PORTION OF THE FOREARM

Injuries of the Soft Parts in the Region of the Elbow.—The more important injuries of the soft parts in this region refer to the bursa mucosa of the olecranon, the capsule of the elbow-joint on the extensor side, and the brachial artery on the flexor side.

The bursae mucosae of the olecranon lie between the fascia and the tendon of the triceps, and between the tendon and the posterior surface of the bone. These are sometimes affected by hemorrhage, the prominent olecranon being specially exposed to injuries. Suppuration follows the infliction of a wound; this may also occur without a wound, the skin being greatly thinned by the presence of a large collection of extravasated blood beneath it and infection taking place from the microorganisms in the skin itself. A **subcutaneous phlegmon** ensues, for which free incisions and antiseptic treatment are necessary. The elbow-joint is not endangered by this suppuration, as the bursae do not communicate with the joint; the olecranon also serves as a protection to the articulation. Tuberculous osteomyelitis of the olecranon, however, may endanger the joint.

Subcutaneous and subfascial phlegmon of the lower portion of the forearm, as well as lymphangitis, may spread to the elbow and arm. Lymphangitis extends to the axilla. The lymph-glands of the elbow are but seldom affected by acute inflammation in connection with septic conditions of the hand and forearm, as only a few of the lymph-vessels empty into these, the greater portion passing directly to the axillary glands. While septic inflammation of the glands in the region of the elbow is very rare, yet **cubital syphilitic lymphadenitis** is very common in cases of general syphilis.

Portions of the joint capsule on each side of the olecranon process are exposed to injury, so that contusions in which the synovial membrane is forced against the bone are not uncommon. The resulting hemarthrosis is not seldom followed by **hydrarthrosis** of the **elbow-joint.**

Injuries of the brachial artery are not rare, as it is more or less exposed in its course from the axillary cavity to the forearm, where it divides to form the radial and ulnar arteries. In most instances the artery is injured by knife wounds. The bleeding is easily held in check by the patient himself or by others through digital compression until the arrival of the surgeon, who places a temporary tourniquet above the point of injury and then explores the wound and applies a double ligature to the bleeding vessel. Failure thus definitely to arrest the hemorrhage may result in **aneurism** or severe secondary hemorrhage, requiring ligation of the vessel in continuity.

Arteriovenous or **varicose aneurism** in front of the elbow-joint is not so frequent at the present time as it was formerly, when venesection was comparatively often performed. Accidents ensuing from the performance of this little operation were not uncommon, the brachial artery being wounded in connection with the vein and a communication established between the two. This finally results in the formation of an aneurismal sac at the place of injury of the artery, with the cavity of which both artery and vein communicate. Or, with the immediate passage of blood from the artery to the vein, the arterial pressure forces the arterial wave through the veins of the forearm without the formation of an aneurismal tumor, dilatation of the veins and pulsation and thrill being the prominent symptoms. Ligation of both the artery and the vein above and below the point of communication or aneurismal sac and excision of the intervening portions is the only trustworthy remedy. This method of treatment is likewise the best for ordinary traumatic aneurism of the brachial artery.

In rare cases **cirsoid aneurism** of the forearm is observed. It may arise from contusions. This condition reaches its highest degree of development in the metacarpal region.

DISLOCATIONS OF THE ELBOW

Dislocations due to inflammatory conditions of the elbow-joint are very rare, owing to the peculiar mechanism of the joint. Congenital dislocations are likewise rare. Dislocations due to injury are second in frequency of the dislocations of all the joints of the body (27.2 per cent, according to Krönlein). They occur more frequently in women and children than in men.

Varieties.—The following are distinguished:

1. Anteroposterior dislocations. These include dislocations backward and forward.
2. Lateral dislocations, including those outward and inward.
3. Divergent dislocations of both bones, *e. g.*, forward dislocation of the radius and backward dislocation of the ulna.
4. Dislocations of the radius alone, including forward, outward, and backward dislocations.
5. Backward dislocations of the ulna alone.

The most frequent dislocation of the elbow is that of backward dislocation of both bones of the forearm. Dislocations of the radius are next in frequency.

Dislocation of Both Bones Backward.—This usually results from hyperextension of the forearm, the patient falling on the palm of the hand, the olecranon acting as a lever and forcing the lower end of the humerus forward. The humerus is really the part dislocated. It may be complete or incomplete. When complete, the coronoid lies behind the humerus, the latter resting on the neck of the radius. In the incomplete form the coronoid is in contact with the trochlea and the head of the radius rests on the capitellum. The capsule is torn and there may be other associated injuries, such, for instance, as rupture of the brachialis anticus, or injury of the vessels of the forearm. There may also be associated fractures, such as fracture of the coronoid, the olecranon, the upper end of the radius, the joint surfaces of the humerus, and the condyles or epicondyles of the humerus. Finally, the dislocation may be compound.

The clinical picture of this dislocation is very characteristic (Fig. 700). The forearm is usually in a position of right-angled flexion; it is sometimes in complete extension. Further flexion is impossible, though the arm may be somewhat extended. The olecranon projects strongly backward with the triceps tendon as a rigid cord. The head of the radius may be palpated in its abnormal position. The condyles of the humerus appear beneath the tightly stretched soft parts.

The diagnosis is made without difficulty in recent injuries and after the swelling has subsided. With extravasations of blood present, however, only quite strong pressure will bring out the relations of the bony prominences to each other. A diagnostic test consists in noting the relation of the point of the olecranon to the epicondyles. In the normal joint these three points are on the same level with the forearm with the latter flexed at a right angle, but in this form of dislocation the olecranon lies at a higher level. This dislocation must be specially differentiated from supracondyloid fracture of the humerus.

Treatment.—The physiologic method of reduction meets all the requirements. The articular surfaces are brought into normal relations by retracting the route taken in the production of the dislocation. The arm is forced into hyperextension, from which position the joint surfaces are separated, and, while flexion is again produced, traction is made on the forearm and pressure made on the olecranon to force the bones forward. The reduction takes place readily. The after-treatment consists in requiring the patient to carry the arm in a sling, passive movements being commenced after fourteen days.

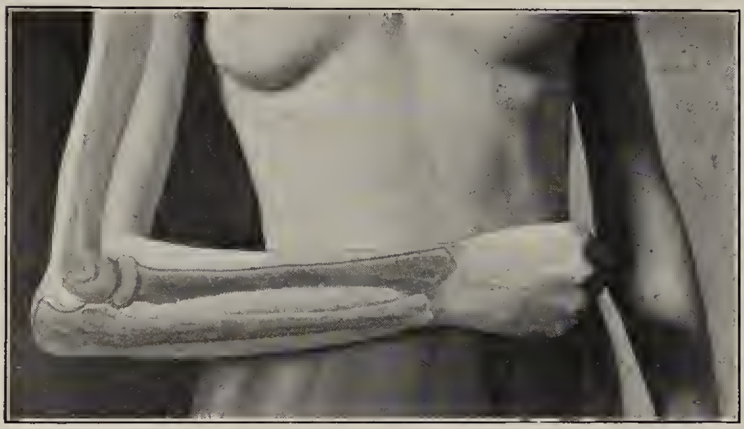
FIG. 700.—BACKWARD DISLOCATION OF ELBOW-JOINT.

The dislocation may be reduced in this way, even after the lapse of weeks. In cases of long standing, however, the method is not so successful, on account of adhesions; after manipulation under an anesthetic, reduction is sometimes accomplished by traction methods. These failing, Trendelenburg recommends temporary resection of the olecranon. The olecranon is exposed by a transverse incision from one condyle to the other and the process separated with the saw or chisel. It is then turned up with the triceps attachment, and the intra-articular adhesions separated. After reduction the sawed surfaces are sutured together. **Resection of the elbow-joint** is reserved for the intractable cases.

In **compound dislocations** the wound is usually situated in front. Most thorough cleansing should precede the attempt at reduction. Should suppuration ensue, in all probability resection will have to be resorted to. **Amputation** is the usual outcome of a case in which the vessels are seriously damaged.

Lateral Dislocation.—This is a variation of the backward dislocation, and is, more properly speaking, a **dislocation backward and outward.** In all probability there is a secondary movement added to the simpler mechanism already described, as, for instance, in the case of a fall forward on the outstretched hand, the weight of the body, after hyperextension of the joint, forces the articular surfaces apart and then, when the body loses its support, a secondary forcible movement occurs. This secondary movement is not a simple flexion, but a **simultaneous lateral inflection,** forcing outward the bones of the forearm.

The dislocation is either **complete** or **incomplete.** The former is rare, yet cases have been reported (Malgaigne). The elbow-joint is enlarged in its transverse as well as in its anteroposterior diameter. The olecranon, the posterior surface of which is usually rotated somewhat outward, can be palpated from behind and outside. The coronoid process rests on the external edge of the posterior intercondyloid fossa or on the external condyle; the radius projects outward. The broad trochlea, as in the usual backward dislocation, elevates the soft parts in front (Figs. 701 and 702). The internal condyle, if not broken off and displaced, is very prominent at the inner contour of the joint. The injury may be complicated by the rupture of the ulnar nerve and the slipping of the brachialis anticus muscle and of the brachial artery behind the condyle. This complication is difficult of reduction; gangrene of the extremity may occur from compression of the brachial artery.

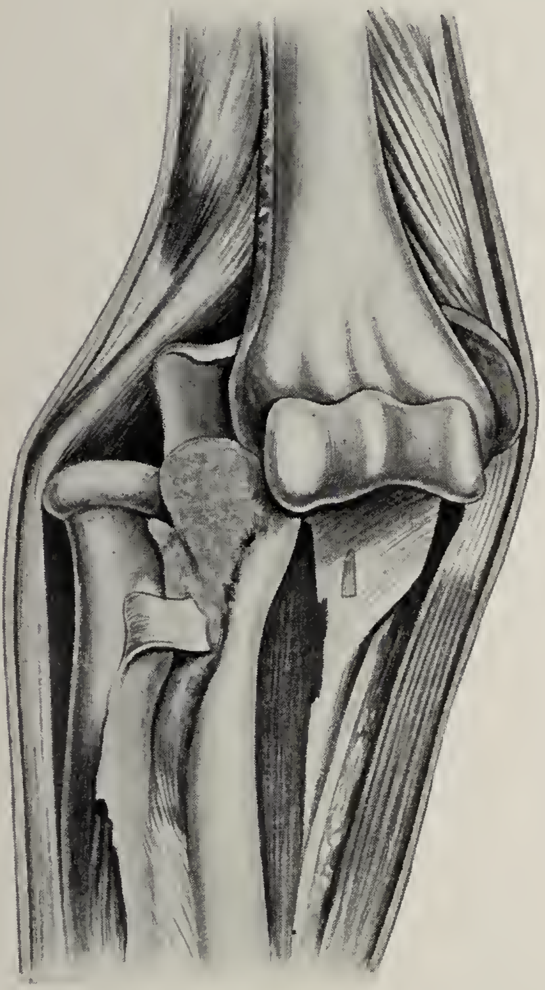
Fig. 701.—Dislocation of Both Bones of the Right Forearm, Backward and Outward.

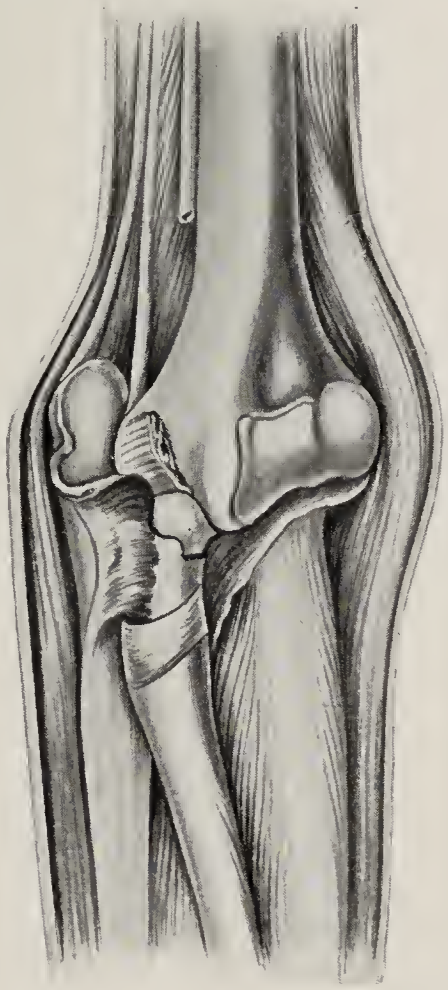
Fig. 702.—Dislocation of Both Bones of the Left Forearm, Backward and Inward.

Incomplete dislocation backward and outward occurs much more frequently than is generally supposed. It probably remains unrecognized in a relatively large number of cases. The clinical symptoms are but slightly marked; the backward prominence of both bones of the forearm is almost entirely absent. The position of the head of the radius is made out with great difficulty, owing to the fact that it is more or less covered by the prominence of the external condyle. In addition to this, the external condyle is frequently broken off by avulsion from the excessive strain on the internal lateral ligament. The extravasation of blood from this source serves to increase greatly the difficulties of diagnosis. Movements of the arm are possible, though restricted, the concave articular surface of the ulna moving on the convex surface of the capitellum of the humerus. Only a very careful examination will disclose the true nature of the injury, and, whenever possible, the use of the Röntgen rays should be taken advantage of to assist in the diagnosis.

Reduction is effected by hyperextension and abduction of the forearm, this being forced inward at the same time, and finally by flexion. The separated epicondyle almost regularly lies in the furrow of the trochlea and may form a barrier to reduction. Should attempts fail to reduce the dislocation by manipulation, the joint is to be opened from behind, the internal condyle removed, and reduction then effected. If the attempts at reduction still fail, the arm is to be placed at a right angle and secured by proper lateral splints or plaster-of-Paris. After fourteen days passive movements are begun with a view of obtaining a useful arm in its dislocated position. Should ankylosis ensue finally, resection is indicated.

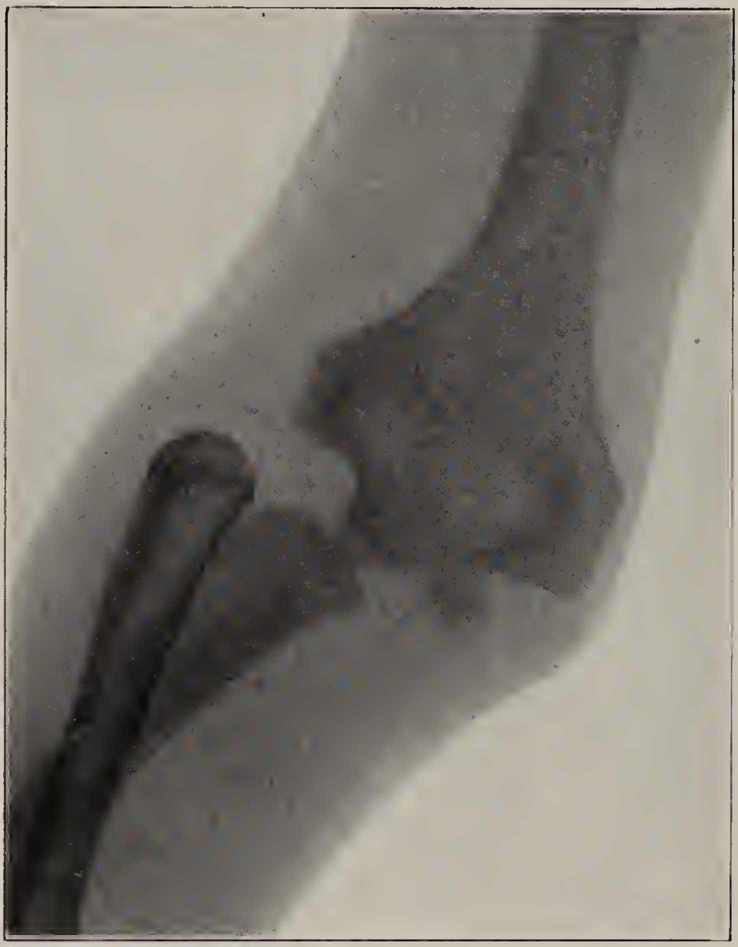
FIG. 703.—DISLOCATION OUTWARD WITH DIASTASIS OF THE EPIPHYSIS FROM THE INTERNAL CONDYLE. Left arm. Seen from behind (from a skiagram).

Dislocation of the forearm backward and inward likewise occurs as either a complete or an incomplete dislocation. Here also there is, in all probability, a lateral inflection following a hyperextension and backward dislocation. The symptoms are evident from Fig. 702.

Dislocation forward from hyperflexion is very rare. It is possible only from a blow or a fall on the olecranon with the arm strongly flexed. About one-fourth of all the cases are complicated by fracture of the olecranon. This is easily explained; the flexion exceeding the physiologic limit, a fixed point is formed at the coronoid process; but complete separation of the articular surfaces does not take place easily, on account of the contact of the flexed forearm with the arm, unless the olecranon gives way. The relations of the parts are well shown in Fig. 704. The reduction is accomplished by forcing the bones of the forearm backward, while the arm and forearm are separated from each other by traction and counter-traction; a movement of flexion closes the maneuver.

Rotation dislocation of the elbow is a complete lateral dislocation of the forearm, in which, in consequence of severe laceration of the soft parts, as, for instance, in a complete outward dislocation, the outer surface of the humerus is embraced by the sigmoid cavity.

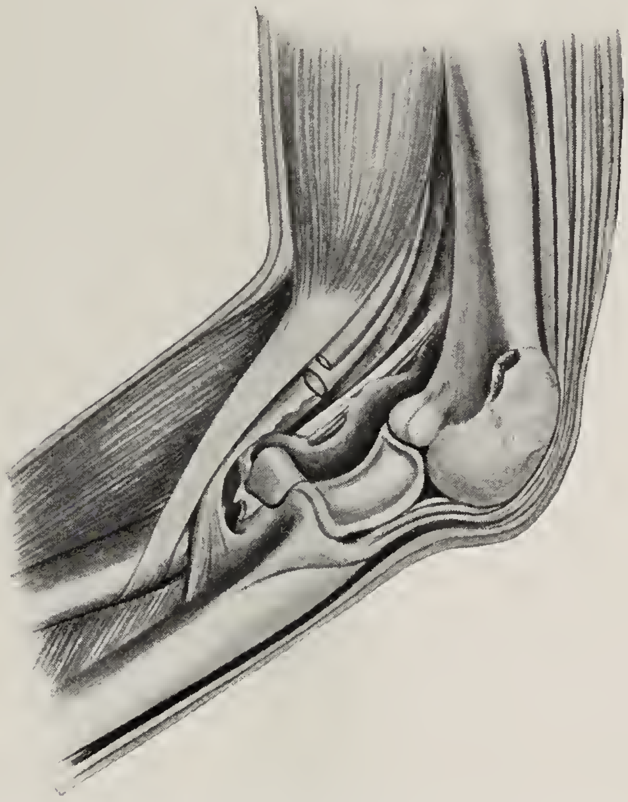

Fig. 704.—Dislocation Forward of Both Bones of the Forearm.

In case of **divergent dislocation** of both bones of the forearm, the ulna is dislocated backward and the radius forward (Fig. 705). Mechanically this injury results from forced pronation and rotation of the ulna around its own axis; the orbicular ligaments must give way to permit forward dislocation of the radius. In the most marked cases the arm has been found in half flexion and full pronation. Or, the head of the radius may rest on the outer and the olecranon on the inner condyle, in which case both bones of the forearm may be broken.

Dislocation of the Elbow=joint with Fracture.—In addition to fractures of the epicondyles, other fractures may accompany dislocations of the elbow-joint. Hueter, in an elbow-joint which he was compelled to resect, observed a fracture of the condyle with backward dislocation of the forearm, and, in addition, fracture of the olecranon and head of the radius. Dislocation backward of the forearm is frequently complicated by fracture of the coronoid process. Compound fractures of both bones of the forearm combined with dislocations of the radius outward and the olecranon inward may occur (see Divergent Dislocations).

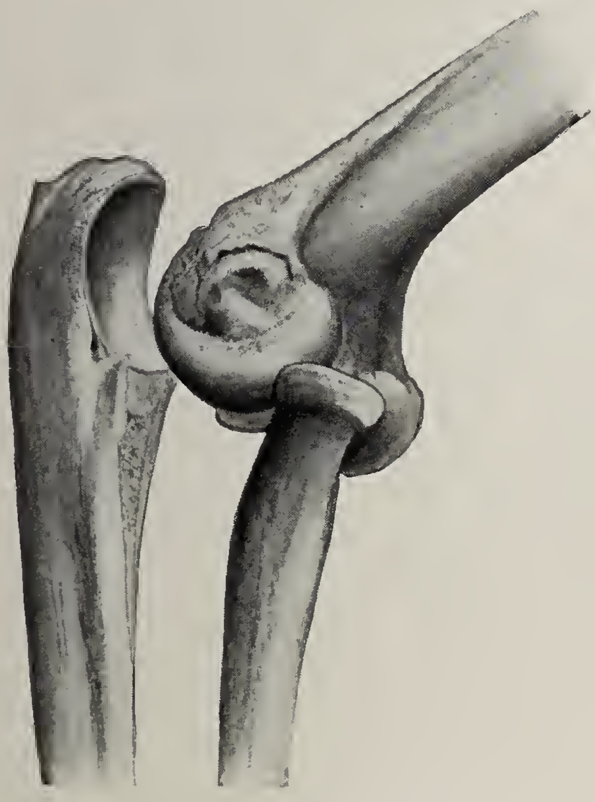

Fig. 705.—Divergent Dislocation of Elbow-joint.

In the treatment of these complicated injuries the dislocated bones and disturbed fragments are to be brought as nearly as possible into their normal positions and the injured joint immobilized for at least four weeks. Should methodic movements fail to restore the joint to a proper degree of usefulness, resection must be resorted to.

Dislocations of the Radius Alone.—**Isolated dislocations** of the radius are not very frequent. Dislocation of the head of the radius forward is the form most often met with. It occurs, as a rule, in young persons and results from a fall on the hyperextended arm, with the hand supinated; there is a lateral inflection of the elbow in addition. Sometimes dislocation forward is accompanied by fracture of the upper end of the ulna. In this case the force acts from behind and serves to produce both lesions simultaneously (Roser).

The dislocated head of the radius, in cases of anterior dislocation, lies between the biceps and the supinator longus and forms an easily palpated prominence. There is an undue prominence of the external condyle because of the absence of the head of the radius. The arm is in a position of half flexion and slight abduction, and can be neither completely extended nor flexed. Attempts to produce flexion beyond a right angle cause the dislocated head of the radius to impinge against the humerus. Reduction may be attempted by traction on the supine and extended forearm. It is exceedingly difficult to retain the bone in position after reduction, the action of the biceps and pronator radii teres drawing the upper end of the radius forward. Retentive bandages of plaster-of-Paris may be applied with the forearm in slight extension and supination in an attempt to keep the radius in contact with the capitellum. In order to avoid partial ankylosis bandages should not be permitted to remain longer than ten days, after which the arm is to be placed in a right-angled position for fourteen days, when passive movements are to be made. In old cases reduction scarcely ever succeeds and resection is indicated. Even in the majority of recent cases a good functional result is rarely obtained without resection of the head of the radius.

Dislocations of the radius **backward,** and **backward** and **outward** combined, are very rare. They occur in young individuals. They probably result from forced supination combined with abduction. The forearm is moderately flexed in a position between pronation and supination; the head of the radius is felt at the elbow behind, to the outer side. Reduction is effected by traction on the supine hand, while at the same time the head of the radius is forced into its normal position by pressure. The arm is put up at a right angle for fourteen days, when passive movements are employed.

A subluxation of the radius forward sometimes occurs in very young children who are grasped suddenly by the hand with the forearm slightly flexed, hyperextension and traction being made at the same time, as in the act of lifting a child by the hand. On account of the want of resisting power in the orbicular ligament in early childhood, the head, thus suddenly acted on, is dislocated inward and forward by the biceps attached to the tuberosity of the radius. In this injury the hand is prone and the forearm is slightly flexed. Supination is difficult and painful; flexion is not usually interfered with.

Reduction sometimes occurs spontaneously. It is sometimes effected with difficulty and requires strong supination with the thumb pressing against the dislocated head of the radius. The head can sometimes be felt to return with an audible sound; sometimes soft crepitation is felt under the thumb as the head slips back into place. Retention is maintained by rectangular flexion and pronation.

FRACTURE OF THE HUMERUS

Fractures of the Shaft of the Humerus.—These are relatively common and occur more frequently from direct than from indirect violence. In indirect violence the force, if affecting the forearm, is usually transferred through the shaft of the humerus to the shoulder-joint, and here produces either dislocation or fracture of the neck. In cases of transverse fracture the displacement of the fragments is slight, specially if the fracture lies below the point of insertion of the deltoid muscle, where the fragments are held in apposition by the brachialis anticus and the triceps muscle. Oblique fractures always show displacement both in axis and in length. In fractures in the middle third the upper fragment is displaced forward and outward by the action of the deltoid and the torn fragment is displaced backward and upward by the triceps. In fractures in the upper third and above the insertion of the deltoid, this muscle draws the lower fragment outward, the upper fragment following the inward traction of the pectoralis major. Sometimes the humerus is inflected by the force producing the fracture, the fragments forming an angle opening outwardly.

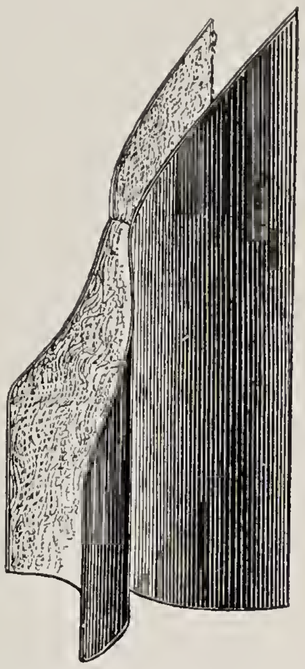

Fig. 706.—Apparatus for the Treatment of Fracture of the Shaft of the Humerus.

The apparatus is shown molded into shape.

The shaft of the humerus is more frequently broken by **muscular action** than is any other portion of the skeleton (57 out of 85 cases, Gurlt). The point of fracture lies usually immediately below the point of insertion of the deltoid muscle. The short shoulder muscles, particularly the deltoid, retain the upper portion of the humerus, the lower portion being carried forward and inward by the strong muscles of the trunk; inflection occurs in consequence of the divergent muscular effort.

The **functional prognosis** following fracture of the humerus is not very favorable, on account of the frequency of failure of union, due to interposition of muscular structures from the brachialis anticus and the triceps, which are extensively attached to the bone. Gurlt found, in 475 cases of pseudarthrosis, that 165 of these affected the humerus. (For Operations for Pseudarthrosis, see Vol. I, page 368.) During such operations on the humerus care must be taken not to injure the musculospiral nerve, which winds round the bone in the musculospiral groove and reaches the outer side of the arm above the elbow-joint at the anterior edge of the supinator longus, thus describing a long spiral around the posterior surface of the humerus. This nerve is likewise liable to injury in case of fractures of the humerus involving the musculospiral groove (see page 458), because of its close attachments to the periosteum; yet this accident is not of such frequent occurrence in common fractures as in gunshot wounds. In some cases after repair of a fracture in this region, symptoms of compression of the musculospiral nerve, announced by pains in the thumb, index and middle fingers (distribution of the radial nerve), and the final occurrence of paralysis, are due to pressure by callus on the nerve, removal of which is followed by restoration of the function of the nerve (see Vol. I, page 335).

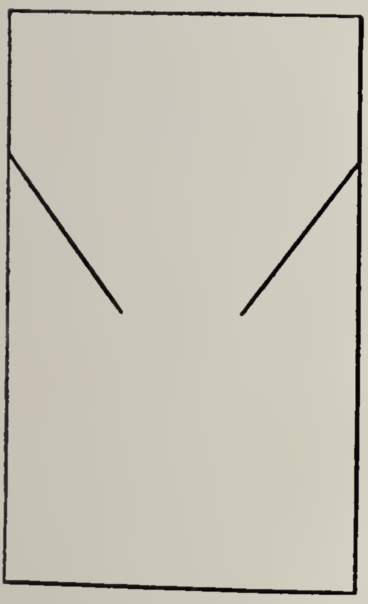

Fig. 707.—Apparatus for the Treatment of Fracture of the Shaft of the Humerus.

Sole leather cut ready for molding into shape.

Reduction of the displaced fragments having been effected, retention is best accomplished by the apparatus shown in Fig. 707. This apparatus is made of sole leather, which is immersed in cold water sufficiently long to render it pliable, after which it is molded into place, where it is bandaged temporarily until it dries and hardens. It is then removed, lined with cotton or wool, and reapplied and held in place by adhesive plaster (Fig. 708). In the absence of a suitable piece of sole leather the same apparatus may be made of wire cloth, with the edges bound with adhesive plaster, or of several layers of canton flannel in which plaster-of-Paris cream has been incorporated. It is well to make a stiff paper pattern first in order to obtain the proper proportions to fit the individual case. After it is secured in position by adhesive plaster a Velpeau bandage is applied. Or, Brewer's spica apparatus may be employed (Fig. 692).

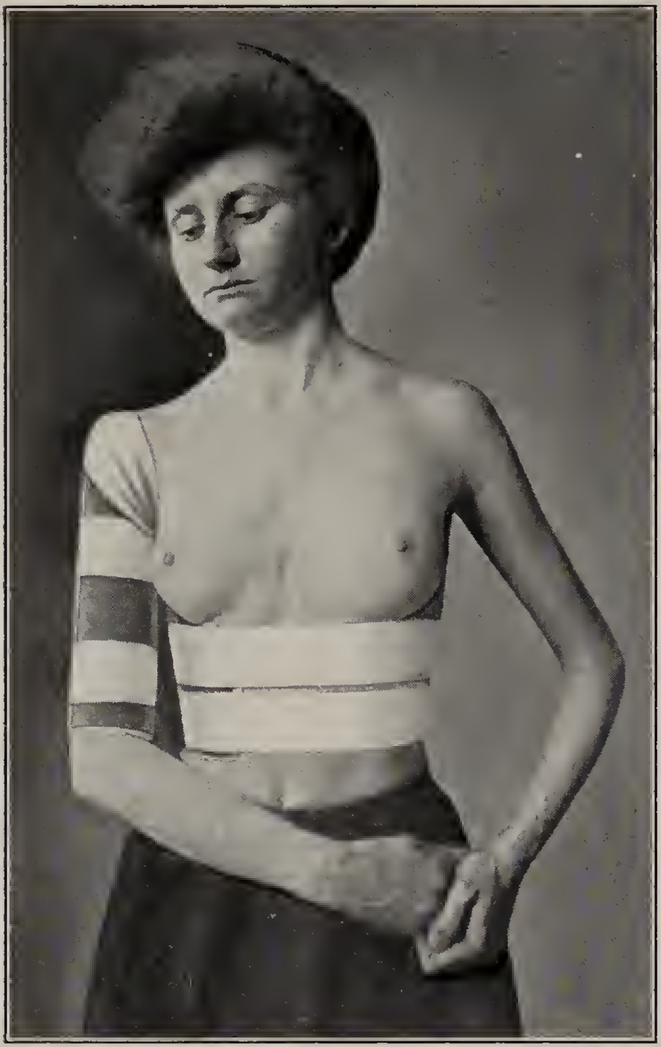

Fig. 708.—Apparatus for Fracture of the Shaft of the Humerus.

The apparatus is shown secured in place by adhesive plaster. The adhesive strip which passes across the axilla and over the shoulder is first applied.

Compound fractures and **fractures due to gunshot wounds** are to be placed in splints with antiseptic dressings applied and kept at rest on a pillow support. Later, when the dressings are to be changed less frequently, a fenestrated plaster-of-Paris splint may be employed. In fractures in the upper third of the arm, with persistent tendency to overlapping, it may be necessary to use extension by weight.

Fractures of the Epicondyles and of the Condyles of the Humerus.—By **fractures of the epicondyles of the humerus (epicondylar fracture,** Fig. 709, A, C, B, D), is to be understood fractures involving the two apophyseal processes to which the lateral ligaments of the elbow-joint, as well as the muscles, *e. g.*, the flexors at the internal epicondyle and the extensors at the external epicondyle, are attached. By **fractures of the condyles (condylar fractures)** is meant fractures of the condyles involving the articular surfaces (Fig. 710). The transverse fracture separating the lower end of the humerus is called the **supracondylar fracture,** and the so-called Y-fracture and T-fracture are called **condylo-intercondylar fractures** (Fig. 710). The last two, with the exception of those due to gunshot wounds, are comparatively rare.

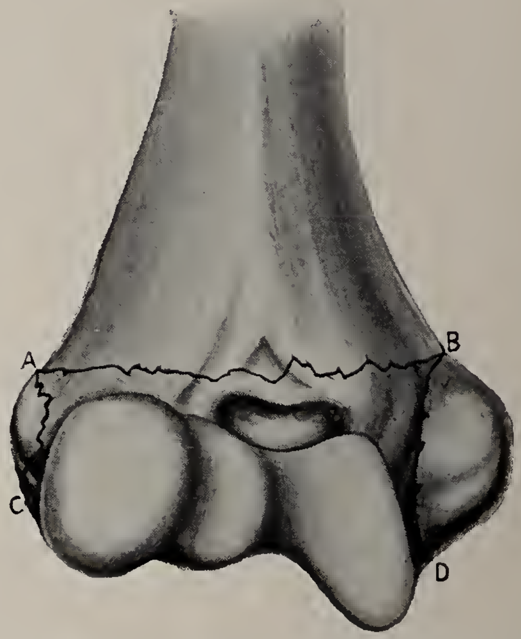

Fig. 709.—Lower End of Humerus, Showing Lines of Fractures at the Elbow-joint.

A, B, Supracondylar fracture; A, C, fracture of the external epicondyle; B, D, fracture of the internal epicondyle.

In the mechanism of dislocations occurring from hyperextension, it has already been stated that the rupture of the ligaments and capsule may be replaced by fracture of the lower articular extremity of the humerus. The elasticity of the ligamentous structures and the soft condition of the bones in children greatly favor such an injury, and it is in those below the twelfth year that it takes place most frequently. It is this **supracondylar** fracture (Fig. 709, A, B) that was formerly supposed to be a **diastasis** or **separation of the lower epiphysis.** This epiphysis is situated lower than the usual line of separation, and the cartilaginous bone separating its two bony nuclei from the diaphysis is completely covered and protected by the ulna.

The general appearance of a supracondylar fracture greatly resembles a backward dislocation of the forearm. Like the latter, it is due to hyperextension and results from a secondary movement of flexion. The broken-off joint end inclosed in its capsule is carried backward; this, together with the very considerable extravasation which usually accompanies this injury, renders the diagnosis very obscure until attempts are made to reduce the supposed dislocation. The true condition of affairs is then made manifest by the ease of reduction by simple traction on the forearm, the existence of crepitus, and the tendency to recurrence after reduction.

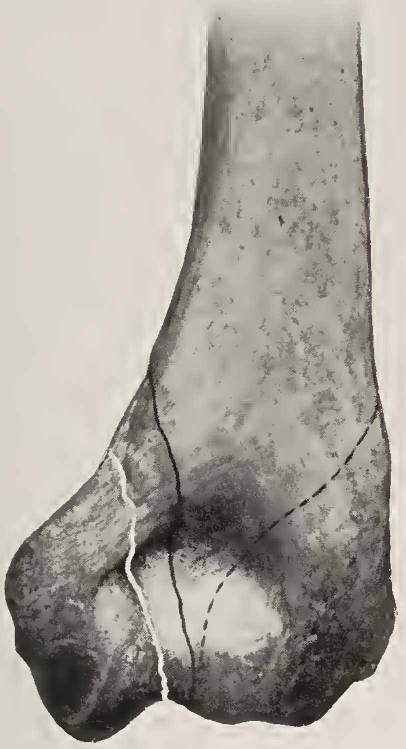

Fig. 710.—Fractures of the Lower End of the Humerus, seen from Behind (Right Humerus). The white line indicates the line of fracture of the internal condyle communicating with the joint (condylar fracture). The black lines indicate the directions which the line of fracture may take in the so-called Y-fracture (condylo-intercondylar fracture).

A peculiar deformity, known as **cubitus varus** (Fig. 712), sometimes results from this variety of fracture, in which there is an angular deviation of the lower fragment with the apex outward. It has been variously attributed to the dressings employed, to the supporting of the limb in a sling under the elbow, to muscular contraction, and to primary displacement of the lower fragment in a fracture by adduction.

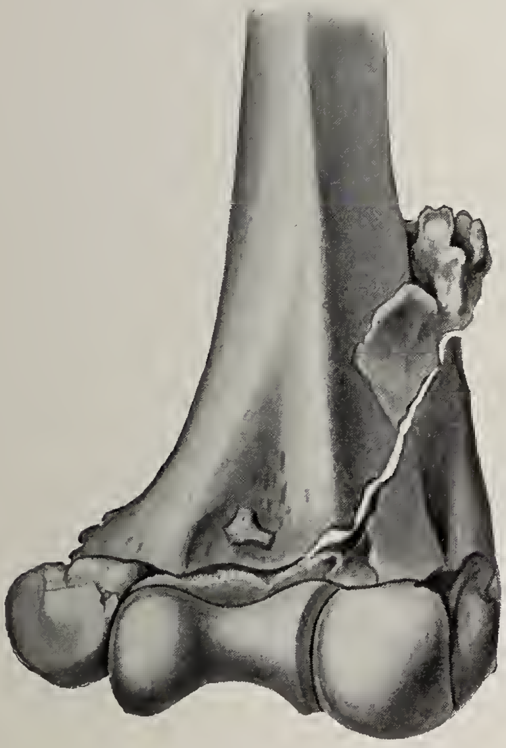

Fig. 711.—Another Form of Supracondylar Fracture of Humerus.

The **function prognosis** of this fracture is much more unfavorable than in fracture of the epicondyles, or fracture of the olecranon. Ankylosis, due to excessive formation of callus and hyperplastic synovitis, is the rule.

Treatment.—The arm is to be secured in anterior and posterior molded splints, made of sole leather or plaster-of-Paris, at a right angle, so that, in case of permanent ankylosis, the elbow will be in a position to insure as wide a range of usefulness as possible. In order to prevent the tendency to cubitus varus, the inner upper portion of the forearm (with the attached lower fragment) is kept well down and pronated, while the splint is hardening, and the use of a sling to support the arm is to be avoided. In children with marked displacement and swelling the patient is kept on his back in bed (Stimson). At the end of two or three weeks, according to the extent and grade of the inflammatory action, methodic passive, and finally active movements are to be instituted and persisted in until normal flexion and extension are obtained. If marked angular deformity is present on the completion of the reparative process, the excision of a wedge-shaped piece from the humerus will relieve the deformity.

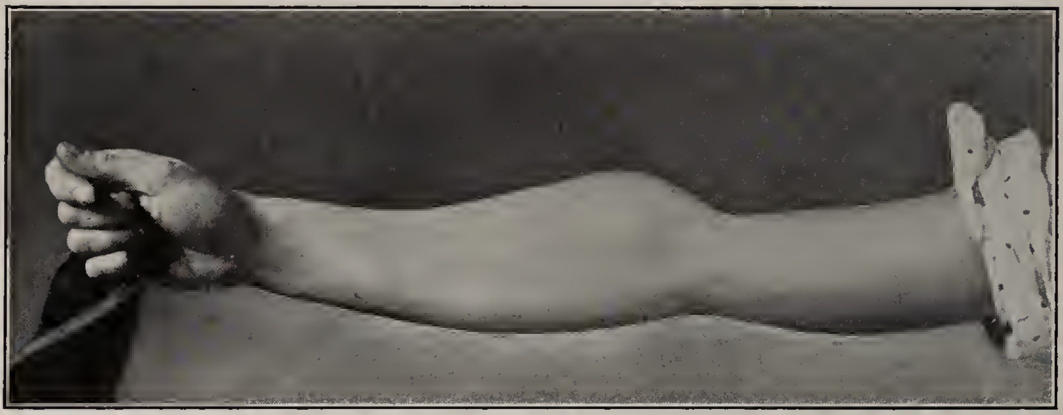

Fig. 712.—Cubitus Varus.

The **diagnostic symptoms of fracture of the epicondyle** are as follows: Extravasation of blood in the neighborhood of the injured epicondyle; pain on palpation of the line of the epicondyles, the thumb of the surgeon's hand pressing on one condyle and the middle finger on the other; mobility of the epicondyle; freedom from pain when slow and careful flexion and extension movements of the arm are made within a certain arc, and sudden pain when the limits of this are reached. This last symptom is due to the fact that the lateral ligaments are not made tense and hence do not disturb the broken-off epicondyle when movements are made only within certain limits; but as soon as these limits are exceeded pain is at once complained of. This distinguishes the lesion in question from condylar fracture, in which the slightest movements produce pain.

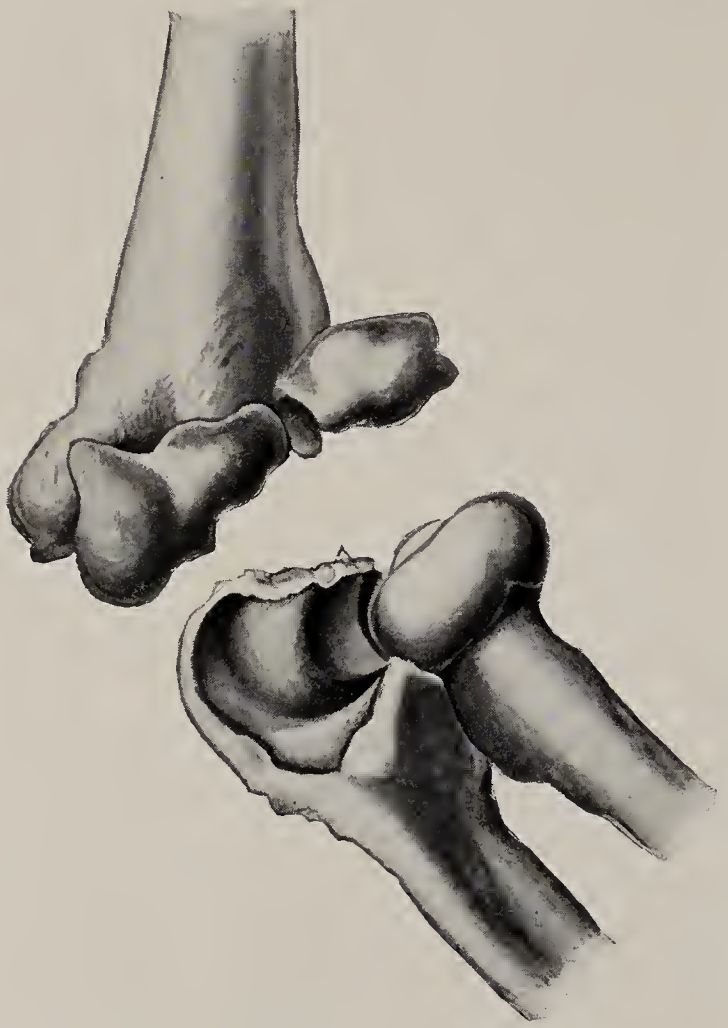

Fig. 713.—Cubitus Valgus (Helferich).
Showing the upward displacement of the external condyle and articular surface in fracture of the external condyle.

It is important that epicondylar fractures be diagnosed and correctly treated. Partial or even complete ankylosis of the joint may result from the formation of callus extending from the epicondyle over the anterior or posterior articular surface of the humerus, or from hyperplastic synovitis attacking the joint surfaces. Ossification of the capsule (synovial callus) has been observed in late resections (Hueter).

The **treatment** of fractures of the internal epicondyle consists in simple immobilization with the elbow at a right angle so as to relieve the tension on the muscles which tend to draw the fragment forward and downward. In **fractures of the external epicondyle,** after reduction of the fragments (which is sometimes extremely difficult), simple immobilization suffices. In case an angular deformity, **cubitus valgus** (Fig. 713), is present, which cannot be reduced, this is to be afterward corrected by a **supracondyloid cuneiform osteotomy** on the corresponding side of the humerus.

Fracture of the Olecranon.—This fracture is of less frequent occurrence than that of the epicondyle, and is due, as a rule, to direct falls, particularly a fall against a sharp edge with the joint sharply flexed. Very rarely it occurs from muscular violence. In recent cases the hemorrhage assumes a roundish oval shape from accumulation of blood in the bursa of the olecranon. As a rule, the collection of blood covers the fracture and masks the latter so that considerable force must be used in making out the separation of the fragments. This latter symptom is due to elastic retraction and to contraction of the triceps by which the broken-off piece of the olecranon is drawn upward. The size of the fragment varies according to whether or not the attached capsule is torn transversely. In **impacted fracture** of the olecranon the cortical lamella is driven into the medullary substance and there is no separation.

In cases of fracture of the olecranon the arm is usually flexed at an obtuse angle. Active extension is not possible, the action of the only extensor of the forearm being destroyed by the breaking-off of its point of attachment. Attempts to make flexion or extension, either actively or passively, are attended with sharp pain and an increased separation of the fragments.

Transverse fracture of the olecranon usually reunites only by fibrous tissue, owing to the separation of the fragments and the fact that the tendinous insertion of the triceps muscle replaces the periosteum. As in the case of the patella, longitudinal fractures unite by bone.

The fracture extends into the joint and is followed by hemorrhage into the joint. Synovitis is present to a greater or lesser extent and some ankylosis of the joint follows from this source. The function is still further interfered with by the stretching of the ligamentous band connecting the fragments, and by the corresponding impairment of the power of extending the arm.

The **treatment** aims to obtain bony union if possible and, this failing, a short fibrous connecting band. The arm should be placed in a position to obtain approximation of the fragments, but it is usually unnecessary to place it in complete extension. An examination of the parts with the arm at an obtuse angle or in partial flexion will usually show the distance between the fragments to be not greater than in full extension. Besides, in the latter position there is danger of producing hyperextension and consequent displacement forward of the bones of the forearm or tilting of the olecranon fragment. A plaster-of-Paris bandage is applied with the arm flexed as much as possible without increasing the separation of the fragments, as shown by making trial of different degrees of flexion. A fenestrum should be cut at the elbow to permit inspection of the parts. A method of treatment that is sometimes successful is to place a fan-shaped piece of adhesive plaster over the area of the triceps and attach its lower extremity to a plaster-of-Paris dressing on the forearm. Malgaigne's hooks have been used in a similar manner. Preliminary aspiration of the joint has been found useful in effecting approximation (Volkmann, Lauenstein). The position of flexion at a right angle is cautiously assumed by gradually but carefully changing the angle of flexion from time to time and applying each time a new plaster-of-Paris bandage. If separation is marked at the commencement in whatever position the arm is placed, the question of **suturing the fragments is to be considered.** This may be done with kangaroo tendon, silver wire, or fine silk. If either of the two former is used, the lower fragment is to be drilled transversely and the suture passed through the triceps tendon. When fine silk is employed, the fibroperiosteal structures adjoining the fracture are sutured. Suturing is not to be attempted unless from ten to fifteen days have elapsed, in order to afford time for the tissues to regain their vital resistance and thus to avoid the dangers of suppuration.

In cases of long standing with marked disability the fibrous connecting band may be excised and suturing performed.

FRACTURE OF THE ULNA AND RADIUS

Fracture of the Coronoid Process of the Ulna.—Fracture of the coronoid process of the ulna is very rare except as a complication of dislocation of the ulna backward. It is produced by falls on the outstretched hand with the forearm almost extended, the force, transmitted through the ulna, driving the coronoid against the trochlea of the humerus. It also arises from excessive contraction of the brachialis anticus, this muscle tearing off its point of insertion into the ulna. Excessive flexion, the coronoid being forced into the anterior condyloid fossa, may also produce it. The olecranon with the ulna may be displaced backward from the trochlea. On palpation the patient experiences pain at the site of the coronoid. Acute flexion is also painful, the more so when this movement is attempted with the hand pronated; the flexion in this case is performed by the brachialis anticus alone, but with the hand in supination the biceps assists and the pains are not so pronounced, since the flexion is performed from the radial side. Active extension also causes pain. This fracture, like that of the olecranon, reunites only by fibrous tissue. The treatment consists in retention, after reduction by placing the arm in a flexed position, with a plaster-of-Paris bandage. If there is marked diastasis of the ulna and trochlea, the surfaces are approximated under a general anesthetic.

Fracture of the Neck of the Radius.—This fracture is somewhat more frequent than that of the coronoid process. It may occur independently or in connection with fracture of the coronoid process. In the former case it results from falls on the radial side of the forearm, the arm striking against some projection, or from blows. In order that the fracture may be produced by a direct blow a considerable force is necessary to overcome the protection afforded by the supinators and the radial extensors of the carpus.

A fall on the prone hand with the elbow-joint extended may result in a **fracture of the head of the radius.** The fracture may consist of a longitudinal fissure, or either the inner or the outer edge may be broken. The fracture is probably due to the impact of the rounded end of the humerus against the head of the radius. The **diagnosis** is made by the **pain** and **crepitation.** The latter is elicited by grasping the forearm with the right hand and making alternate pronation and supination, the examiner's thumb being placed over the head of the radius beneath the external condyle. The treatment consists in placing the elbow at a right angle with the forearm half-way between pronation and supination, the palm being parallel to the anterior thoracic surface. The fracture is repaired by bony callus; the function of the joint is not impaired.

INFLAMMATION OF THE ELBOW-JOINT

Infected wounds of the elbow-joint, particularly **gunshot injuries,** produce the usual grave symptoms of suppuration of joints. The capacity of the cavity of the capsule is slight and therefore the suppurating surface is restricted, but the accumulated pus is under considerable pressure, particularly at the anterior surface of the joint, where the capsule is strengthened by the tendon of the brachialis anticus, and high temperature is therefore one of the distinguishing characteristics of inflammation of the elbow-joint. The capsule is perforated early and infiltration of the surrounding connective tissues takes place. This occurs specially at the upper portion of the bend of the elbow and appears as a phlegmonous inflammation, extending to the arm beneath the brachialis anticus and the biceps.

Tuberculous osteo=arthritis of the elbow-joint, with the osteal conditions predominating, occurs as the result of primary foci in the ulna as the most common seat of deposit. These appear most frequently at the line of the epiphysis, near the olecranon. The next most frequent sites of primary foci in connection with disease of the elbow-joint are the lateral portions of the humerus, in the direction of either epicondyle. These deposits are frequently multiple.

Syphilitic inflammation is relatively frequent at the elbow-joint, particularly in young children affected with congenital syphilis.

The **vital prognosis** of inflammation of the elbow-joint is serious. The **functional prognosis** also deserves consideration, for the reason that ankylosis in extension means a useless arm. In addition, all restriction of motion leads to impairment of function and loss of strength of the whole arm.

Primary extra=articular suppuration at the elbow may originate from the lymphatic glands in the bend of the elbow or those situated above the internal condyle, and also from the bursae mucosae surrounding the joint. Of these latter, the bursae mucosae of the olecranon are affected most often; the irregular epicondylar bursae rarely suppurate. Occasionally an isolated focus of osteomyelitis in the humerus perforates externally, instead of into the joint, forming an extra-articular abscess.

Treatment of Inflammation of the Elbow=joint.—Tuberculous inflammation of the elbow-joint is treated from the commencement by immobilization at a right angle by means of a plaster-of-Paris bandage. Intra-articular injections of iodoform and sterilized glycerin, and such measures, are of slight benefit for the reason that the primary focus is almost invariably in the bone. The exact situation of the primary focus or foci is not apparent; when the joint cavity is involved, rapid suppuration ensues and the iodoform and glycerin injections are absolutely futile in the presence of the microorganisms of suppuration. Even with suppurative changes, however, free incision and, if possible, the clearing away of a primary tuberculous focus and the application of pure carbolic acid to this, and to the entire joint cavity as well, followed by the application of 95 per cent alcohol, offer a fair prospect of success, if free drainage is afterward employed. But unnecessary delay in applying the radical and most promising means of getting rid of the affection, namely, resection, may cost the patient his limb and perhaps his life. **Early** and **local** resection is urgently indicated in order to avoid functional and vital dangers from tuberculous disease of the elbow-joint.

Suppurative synovitis, particularly the traumatic variety, as occurring in connection with suppurative osteomyelitis and periostitis, likewise demands prompt interference. As a rule, nothing short of resection will provide efficient drainage. Resection improves both the vital and the functional prognosis in this class of cases and likewise shortens very considerably the duration of the treatment.

Intermediate resection, that is, resection within a few days after the injury when septic conditions are present, and before the supervention of profuse suppuration, is, as a rule, indicated in case of gunshot wounds from the older patterns of firearms. Those received from a Mauser or a Krag-Jorgensen arm offer a much better prognosis and may induce but slight, if any, suppuration, particularly if the first-aid dressing has been promptly applied. But, in cases in which resection becomes necessary, this should not be delayed.

Free Bodies in the Elbow=joint.—Separation of small portions of the head of the radius, or of the articular surfaces of the rounded lower end of the humerus results, later on, in movable bodies in the joint or "joint mice." During movements of the elbow these sometimes become incarcerated between the joint surfaces and give rise to sudden pain and temporary loss of function. These attacks are usually followed by serosynovial effusion and even by hyperplastic growth of the joint constituents, thus giving rise to a condition resembling that of the panarthritis of arthritis deformans. The friction sounds of the movable body may be heard and the roughened synovial and cartilaginous surfaces felt. If the movable body is situated posteriorly, it may sometimes be felt distinctly; if in the anterior portion of the joint cavity, it cannot be palpated.

The **treatment** depends on the amount of disability present. If this is sufficient to warrant it, **arthrotomy** should be performed and the body removed. The incision is made alongside the olecranon; the latter may require **temporary resection** in order to gain sufficiently free access to the joint. Should this not succeed, it may be necessary to perform resection of the joint.

Tumors of the Region of the Elbow and Its Neighborhood.—The region of the elbow is marked by the occurrence of **varicose aneurism** and other forms of **aneurism of the brachial artery,** as well as by **hygroma of the bursa mucosa of the olecranon.** Hyperplasia of the synovial lining gives rise to papillary growths, which separate partly and form the so-called "rice bodies." Old hygromas of this bursa often contain many of these bodies. Deposits of urates have also been observed in this bursa. The **bursa of the biceps** is the seat of hygroma much more rarely than the bursa of the olecranon.

While a lipoma of the shoulder sometimes reaches to and even below the insertion of the deltoid, and a sarcoma of the biceps and triceps descends downward on the arm, yet, in the lower third of the arm, and in the upper third of the forearm, these tumors are very rare.

Myxoma of the ulnar nerve, capillary angioma, and melanotic sarcoma of the skin are still more rarely observed in the region of the elbow. **Epithelial** carcinoma at the elbow has been observed by Esmarch.

The lymphatic glands in this neighborhood rarely become enlarged except as a part of the general infection of syphilis. Those lying at the inner edge of the lower portion of the tendon of the triceps are usually palpably enlarged in this disease.

Tumors of bone are still more rare in this region. Langenbeck, however, removed the entire ulna on account of **sarcoma** that had developed during pregnancy.

A supernumerary apophysis sometimes develops just above the internal epicondyle, known as the **supracondylar process,** which is said to occur as a hereditary anomaly. It is curved downward like a hook. The pronator radii teres has its origin from this abnormal bony process and the brachial artery and accompanying nerves pass behind it.

Sequestrotomy at the Humerus.—This operation is sometimes required for infectious osteomyelitis of the humerus. The disease attacks the upper arm much more frequently than the lower. The sequestrum, in cases of **total sequestrotomy** of the upper arm, includes the shaft up to the line of the epiphysis; the disease separates the head from the shaft at the epiphysial line and the head is left behind in the glenoid cavity in the operation.

Sequestrotomy at the humerus is not a very difficult operation. The fistulas usually lie at the posterior surface of the arm and away from the large vessels. The most important structure directly endangered is the musculospiral nerve as it winds around the posterior surface of the humerus. More rarely the milder form of infectious osteomyelitis, called by Ollier *périostite albumineuse,* occurs in the humerus.

Acute osteomyelitis attacks the ulna only in rare instances; the radius is still less frequently affected. **Syphilitic periostitis** and **ostitis,** however, are relatively frequent in both bones.

Ligation in Continuity of the Brachial Artery.—This vessel can be ligated in any part of its course. Either one of two places, however, is selected, namely, the middle of the arm and the bend of the elbow.

For ligating the brachial artery in the middle of the arm, an incision is made two to three inches long on the inner edge of the biceps. The fascia of the arm is divided and the innermost fibers of the biceps muscle exposed. The median nerve is now sought. When the nerve is drawn inward with a blunt hook, the artery is exposed (Fig. 714). The vein and ulnar nerve lie further inward on the intermuscular septum which separates the biceps from the inner portion of the triceps.

One of the difficulties met with in this operation is the high division of the brachial artery into the radial and ulnar arteries, or the bifurcation of the axillary to form these two vessels. Abnormal origin of the radial and ulnar arteries is the most frequent abnormality of large vessels observed. If an abnormally small vessel is met with in the normal location of the brachial, or if such a vessel is met with more superficially placed than that vessel, a deeper dissection is to be made until the intermuscular septum before mentioned is reached, in order to determine whether or not there is another vessel.

Ligation of the Brachial Artery at the Bend of the Elbow.—The site of the biceps tendon is defined and an incision, about two inches long, made a little to the inner side of the tendon. This is continued through the superficial fascia, the basilic vein and the internal cutaneous nerve, which lie together, being avoided. The deep fascia is then divided, immediately beneath which the artery lies with its venae comites. The needle is passed from within outward so as to avoid the median nerve.

Suture of the nerves at the bend of the elbow, both as a primary and as a secondary procedure, is sometimes required.

Suture of the Musculospiral Nerve.—In cases of fracture of the shaft of the humerus this nerve may be injured in the **musculospiral groove,** where it lies close to the bone; or in the neighborhood of the bend of the elbow, where it may be torn in injuries to the lower end of the humerus or in compound dislocations of the elbow-joint. The incision is made obliquely along the outer border of the biceps muscle and the nerve identified where it emerges from the musculospiral groove and lies between the supinator longus and the brachialis anticus.

If the nerve has been injured above this point, it may be traced upward, the triceps being divided if necessary; if below the point where it has been exposed, it may be traced downward to the point where it emerges beneath the outer edge of the biceps and divides into the posterior interosseous and radial.

Resection of the Elbow=joint.—The lower end of the humerus and the upper extremities of the ulna and radius are removed.

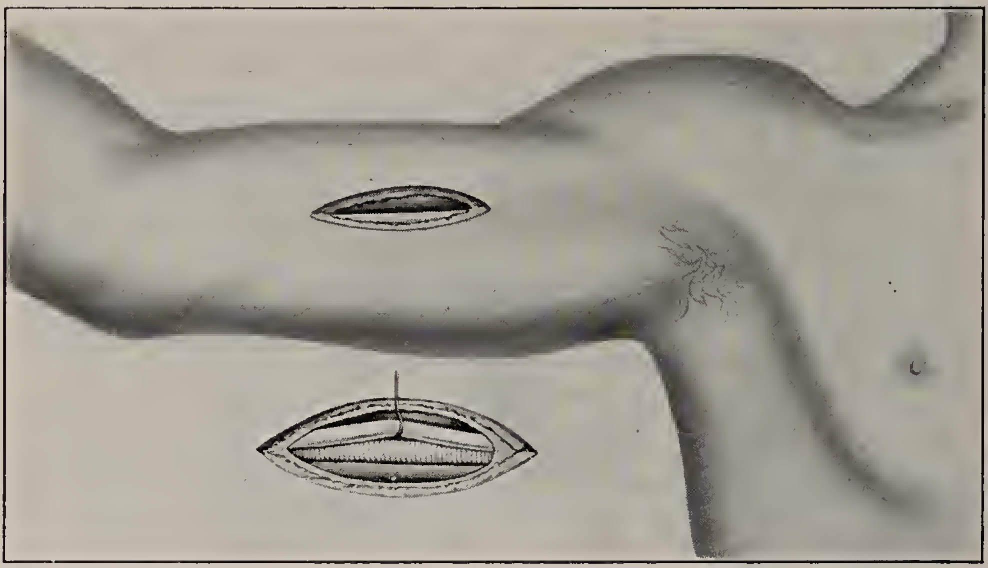

FIG. 714.—LIGATION OF BRACHIAL ARTERY IN THE MIDDLE OF THE ARM.

Posterior Longitudinal Incision (Langenbeck).—The forearm is strongly flexed. A four-inch incision is made, somewhat nearer the internal than the external condyle, with its center resting on the tip of the olecranon (Fig. 715). The triceps tendon is split and separated from the bone. The inner portions of the muscle and tendon, together with the loosened periosteum of the ulna, are separated in the direction of the internal condyle. The thumb of the left hand, aided by a blunt retractor in the hands of an assistant, stretches the soft parts while the periosteum and capsular insertions are loosened by the elevator or resection knife. As the internal condyle comes into view the internal lateral ligament is separated by an incision carried closely around the prominent condyle. The ulnar nerve is retracted with the soft parts and does not come into view. When the internal lateral ligament is completely separated, the bones of the forearm can be lifted from the articular surface of the humerus.

The separation of the soft parts at the external condyle is carried out in the same manner. The triceps and the other soft parts are retracted in an outward direction, the capsule separated from the external portion of the trochlea and capitellum, and, as the external condyle comes into view, the external lateral ligament is loosened, the knife following the bone closely. The joint gapes widely, and the bones are cleared for sawing.

The articular portion of the humerus is first removed; in extensive disease more of the bone may require removal. The hand is to be placed in a position midway between supination and pronation and the bones of the forearm sawed across, as much of these being saved as possible.

Ollier's Method (Fig. 716).—This method is specially adapted for atypic resection, as, for instance, in ankylosis in the extended position, and for exploratory arthrotomy. The first or upper part of the incision is vertical and corresponds to the interval between the triceps and the supinator longus. It commences about 2½ inches above the line of the articulation and extends down to the external condyle. The second or central part crosses obliquely inward to the base of the olecranon. The third or lower portion follows the posterior border of the ulna for about 2 inches. A short supplementary incision an inch long is made in a vertical direction over the internal condyle. The object of the latter incision is to facilitate the separation of the attachment of the internal lateral ligament.

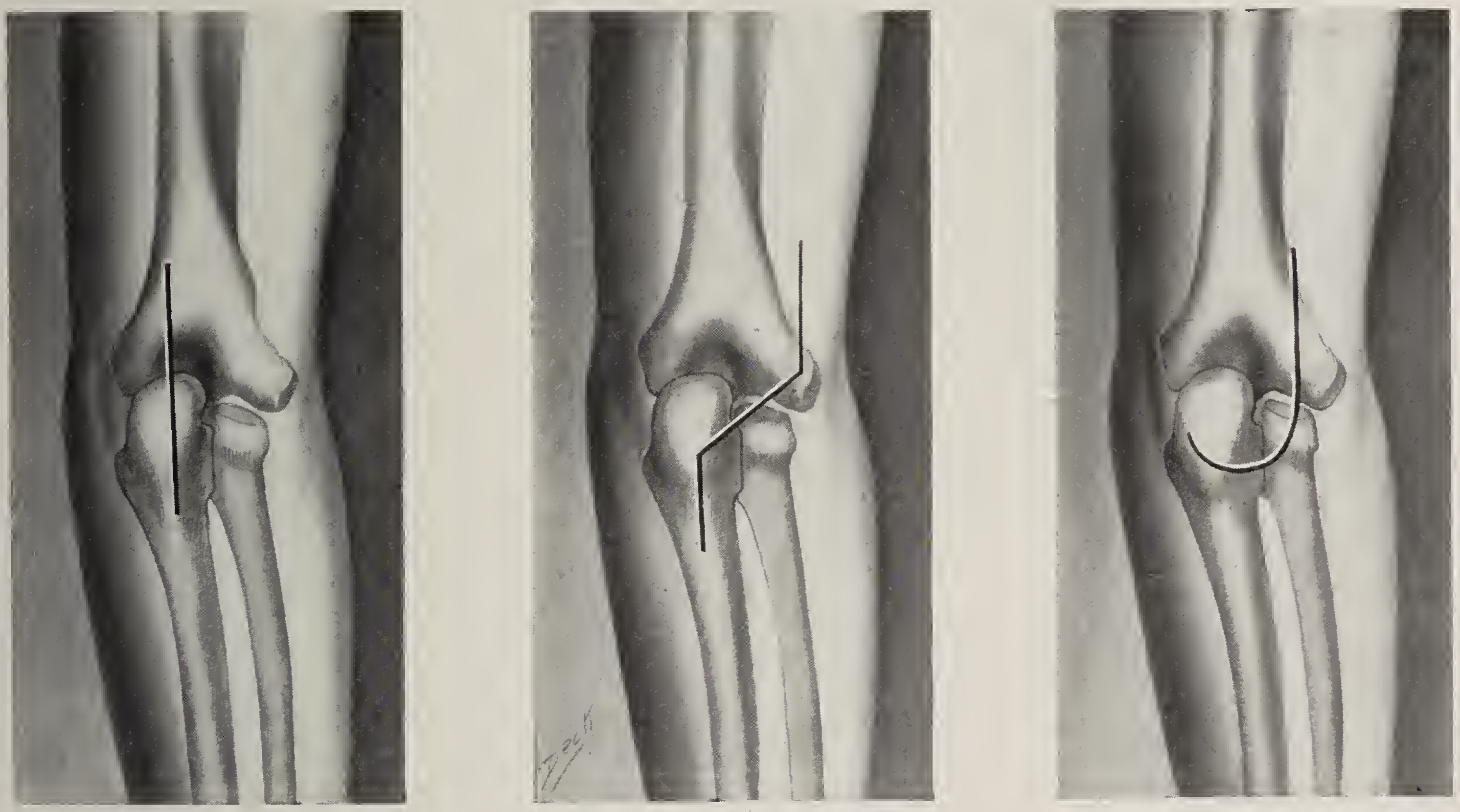

Fig. 715. — Langenbeck's Incision.

Fig. 716. — Ollier's Incision.

Fig. 717.—Kocher's Incision.

Incisions for Resection of the Elbow-joint.

Kocher's Method.—The incision commences on the external border of the humerus about two inches above the line of the joint, and is carried parallel to the long axis of the humerus to the head of the radius. Here it curves, corresponding to the lateral edge of the anconeus muscle, toward the border of the ulna, from which point it is carried upward for about an inch. The concavity of the incision is from 1¾ to 2¼ inches below the tip of the olecranon (Fig. 717). The upper portion of the incision is carried directly down to the lateral border of the humerus, the extensor carpi radialis longior, the extensor carpi radialis brevior, and the extensor communis digitorum lying behind the incision. The capsule is opened at the posterior external circumference of the radius, the incision is carried between the lateral edge of the anconeus and the extensor carpi ulnaris, so that, in addition to the capsule, the periosteum is also incised. By this incision injury to the nerve-supply of the forearm is avoided.

The olecranon is severed at its base by the chisel, turned aside with its attached muscles and tendons, and displaced toward the ulnar side. If healthy, it may be subsequently replaced (temporary resection of Victor Bruns, Trendelenburg and Völker), or if diseased it may be dissected loose and removed. The external lateral ligament and the capsular attachments at the external condyle and the neck of the radius are loosened, when the joint can be made to gape widely, while the muscles and nerves, the entire extension apparatus, maintain their normal connections with one another. The internal lateral ligament is loosened from the inner edge of the ulna, together with the soft parts from the anterior surface of the trochlea, the muscular structures cleared from the internal and external condyles as far as necessary, and the articular extremities of the radius, ulna, and humerus removed with the saw.

When the olecranon is not removed, the sawed surface of the ulna is to be left concave from before backward, or somewhat parallel to its original articular surface, the functional result being thereby greatly improved when a movable joint is secured.

The Question of Total or Partial Resection of the Elbow-joint.—The dangers of a loose and flail-like false joint, and hence a comparatively useless arm requiring the aid of artificial means to perform any of its functions, increase with the amount of bone removed. In extensive gunshot injuries it is not necessary to remove every particle of injured bone. Dangers of suppuration of the joint will be lessened by removing a thin slice from the joint ends, but it is not necessary to saw off the bones as far as the fissures extend. In case of oblique fracture of the lower end of the humerus the entire surface may be involved and require removal, the pointed end being smoothed off with the saw or the bone-cutting forceps. Under these circumstances a useful arm may be obtained, the preservation of the longer piece of bone, together with the olecranon, favoring a movable joint. In shot wounds ankylosis is more frequent after partial resection. As this condition is more desirable than a loose (flail-like) joint, partial resection is here also indicated, as far as function is concerned, though it must be confessed that, from the aseptic standpoint, greater risks follow partial than total resection.

Tuberculosis of the joint demands total resection, for the reason that tuberculosis of bone is far more common than tuberculosis of the synovial membrane, often occurring in multiple foci, one or more of which might be easily left by a partial resection. Even if the disease were limited to the synovia, complete extirpation of the capsule would be next to impossible without total resection.

The choice of operation in partial resection will depend on the part to be removed. If the humerus is to be left almost entire, Langenbeck's incision will be preferable, while if the olecranon can be preserved, that of Kocher, or some modification thereof, will be better adapted.

Fibrous ankylosis in the straight position with but slight solidity may require resection of a portion of the articular surface. In **bony ankylosis**

removal of a wedge-shaped piece, including the ankylosed surfaces, will be necessary.

The After-treatment of Resection of the Elbow-joint.—The arm is to be thickly enveloped with aseptic gauze dressing and aseptic cotton-wool and placed at first on a right-angled wire splint, or a fenestrated plaster-of-Paris splint may be employed. If a movable joint is aimed at, the use of an open wire frame suspended in an easy position, with bandage material stretched across from side to side, will be indicated. When total resection is performed, under which circumstances bony union of the sawed surfaces gives the most useful arm, a splint which will keep the parts immobile, and at the same time permit access for dressing purposes, is to be used. The form of splint shown in Fig. 718 is very useful. It is of plaster-of-Paris and embraces the arm and forearm only, with a connecting "bridge" on the anterior surface. A number of turns of plaster-of-Paris bandage encircle the forearm and arm alternately, the bridge being formed of the same bandage as it passes to and fro from the forearm to the arm.

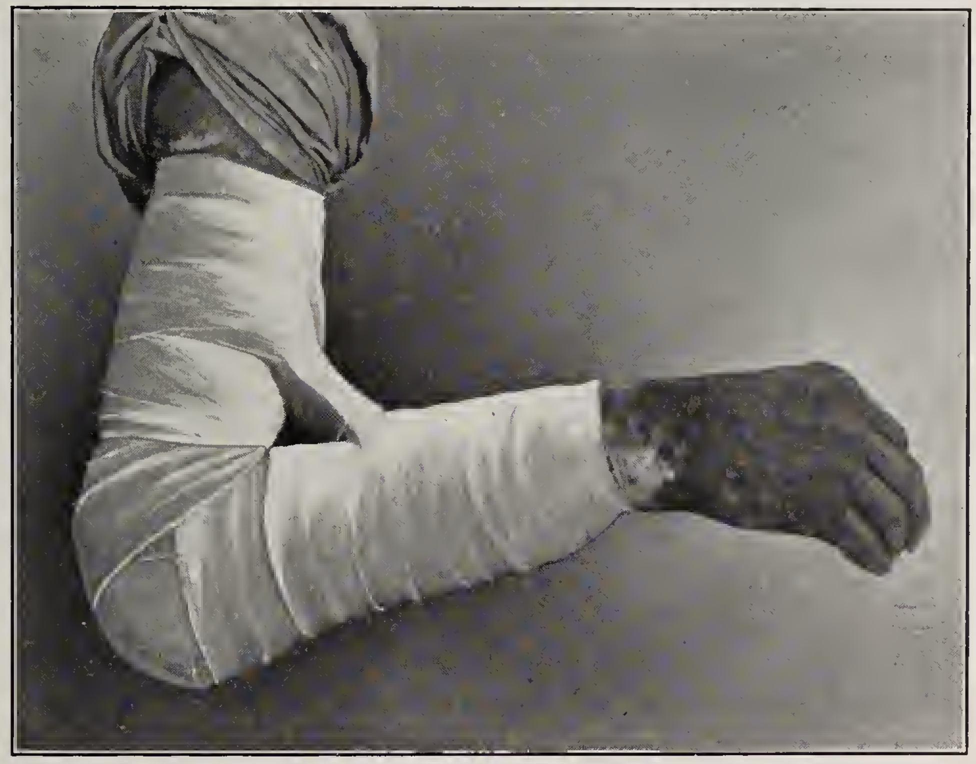

Fig. 718.—Plaster Bridge Elbow Splint.

For the after-treatment of resection of the elbow-joint. Only the parts connected together by the "bridge" are of plaster-of-Paris. The remainder is simple bandage material retaining the dressings in position.

As a rule the patient may leave his bed after the first week. In the movable joint cases daily passive movements in the normal directions may be commenced as soon as healthy granulations fill the wound. In these injuries cicatrization is under way in from four to six weeks; in shot injuries the period is longer. These movements are to be followed as soon as practicable by the patient's voluntary movements. These are to be persisted in, particularly those of flexion, supination, and pronation, the arm being held alongside the body and slightly abducted.

Amputation of the Arm.—This operation is most frequently indicated by severe crush injuries, particularly those of the forearm. Next in frequency comes tuberculous osteo-arthritis of the elbow, in cases in which resection is no longer possible or in which recurrence has taken place. Sarcoma of any portion of the humerus can be radically extirpated only by amputation of the entire upper extremity (see page 440).

Amputation of the arm is the simplest of all the amputations. The usual circular amputation in two lines, the one for the skin and the second at a higher level for the muscular structures and bone, usually suffices. Either the oval or the flap incisions may also be employed. In order that the resulting cicatrix may not lie directly on the end of the stump the circular incision may be made obliquely, instead of transversely, with its upper end in the internal bicipital groove (Kocher). In the flap methods the skin flap may be taken either from the anterior or from one of the lateral surfaces. In traumatic cases in which the soft parts are injured at a higher level on one side of the bone than on the other, and in which the circular amputation sacrifices too much healthy tissue, flaps are to be formed to suit the individual case. The Esmarch constrictor is to be first applied. The sawed surface of the shaft of the humerus is not large at whatever point the amputation is performed, and comparatively small flaps suffice to cover the bone. Of the muscular structures those on the external surface retract the most; those on the internal surface, having their origin in the humerus itself, retract comparatively little. In making the section of the muscle allowance should be made for this difference in retraction. A periosteal flap is made by peeling back the brachialis anticus and the two lateral heads of the triceps, together with the periosteum. In this manner, after the section of the bone, a covering of periosteum lies over the sawed surface. Before the application of the saw care must be taken to isolate the musculospiral nerve; this is to be divided separately and not by the saw. After ligation of the vessels, the flaps are sutured and provision made for drainage. In circular amputation the line of suturing is placed anteroposteriorly (vertically as the patient lies) and a drainage-tube led out of the posterior (lower) angle.

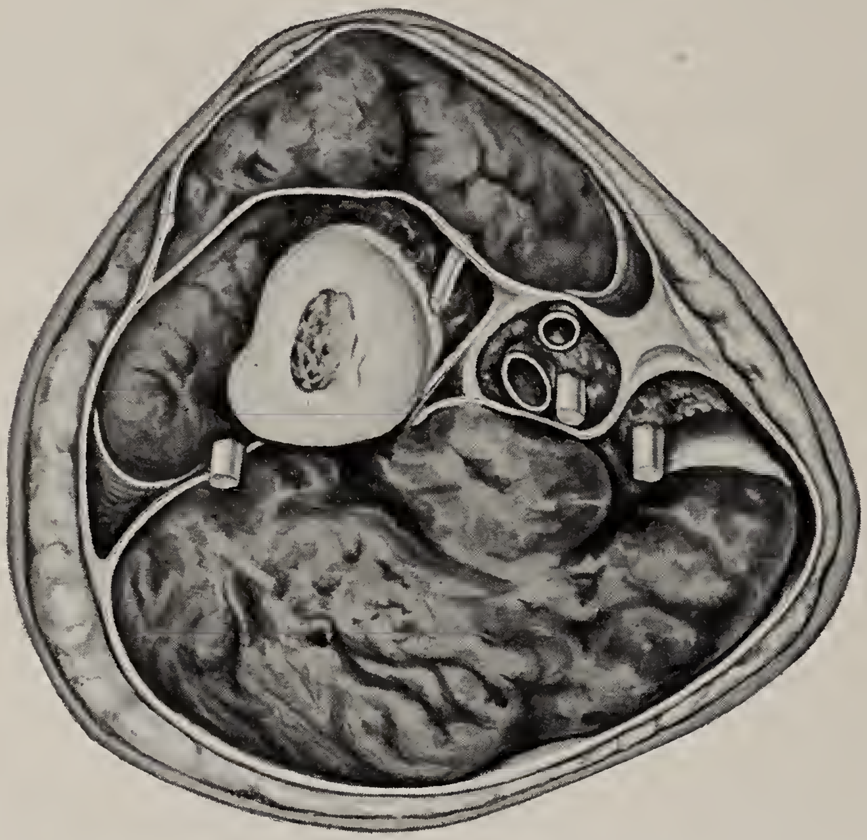

Fig. 719.—Transverse Section through Middle Third of Right Arm.

Before the days of antisepsis the mortality was 21.4 per cent (Surgeon General's Report of the Civil War). The mortality at the present time is practically *nil*.

Amputation of the Elbow-joint.—Whenever possible the section should be made below the elbow-joint, the attachments of the biceps and triceps in the stump being retained. In the case of extensive crush injuries, however, it may be necessary to amputate through the joint. The operation is best performed by circular section, the forearm being encircled at a point about three fingerbreadths below the line of the articulation. A much larger flap is required here than in the arm, not only on account of the greater area of bone to be covered, but because of the tendency of the skin to retract in this region. The skin is loosened from the fascia by a few touches of the knife; the muscles are divided on the anterior surface of the joint and the latter opened. The lateral ligaments are divided and the bones of the forearm dislocated backward by hyperextension. The separation of the insertion of the triceps at the olecranon completes the operation. After the vessels are secured the skin edges are united transversely, the stump being thus made to correspond in shape to that of the end of the humerus, and a fenestrated drainage-tube inserted so as to emerge at both angles.

In the flap method the anterior flap is quadrilateral and the posterior one semicircular. The base of the anterior flap is placed about an inch and a half below the epicondyles. The dissection in front is carried to the capsule, which is opened. The joint is incised transversely, from a point commencing at the radial side, and the lateral ligaments divided. The forearm is now superextended and the triceps attachment divided. The amputation is completed by freeing the posterior flap.

The advantages of amputation at the elbow-joint were formerly due to the immunity from septic conditions involving the medullary cavity of the humerus. At the present time, with proper precautions, this would scarcely be taken into account. In the application of an artificial limb following this amputation the joint must necessarily fall below the level of the normal joint. From this point of view it is held by some that amputation in the shaft of the humerus is preferable. The amputation at the elbow-joint will probably, however, always hold its place among surgeons.

Neuromas develop with comparative frequency after amputations in the arm and elbow-joint. In extirpating these care should be taken to avoid injury to the brachial artery.

THE LOWER PORTION OF THE FOREARM, WRIST, AND HAND

THE FOREARM

Injuries of the Soft Parts of the Forearm.—Superficial wounds of this region are not specially important. Those, however, which penetrate the fascia and invade the region of muscular structures are liable to set up a **traumatic septic phlegmon** of the connective tissue between the muscles and the tendons. These phlegmons become more extensive on the anterior surface of the forearm on account of the widespread planes of connective tissue between the flexor muscles. These large and multiform surfaces are overcome with great difficulty by incision and drainage, which, in some cases, must be frequently repeated. New foci constantly make their appearance, and incisions, as at first planned, must be extended and new ones made to meet the constantly changing conditions. The important functions of the hand and fingers are threatened, and even life is endangered. Sloughing of the tendons occurs, and the formation of cicatricial adhesions between those which are preserved, as well as agglutination of the muscular tissues, greatly impairs their usefulness.

Transverse division of the tendons requires **immediate tendon suture** in fresh wounds, and **secondary tendon suture (tendoplasty)** in those in which the suturing was not done in the first instance, and which have healed with separation of the ends of the divided tendons.

Injury of the Median Nerve.—This nerve may be injured just above the wrist, where it lies superficially in the median line between the flexor tendons. Usually, when complete division of the nerve takes place, the tendons of the palmaris longus and the flexor sublimis digitorum are injured at the same time. **Division** is followed by paralysis of sensation of the ulnar side of the thumb and palmar surface of the index and middle fingers. The wound must be enlarged and the divided ends of the nerve secured and sutured. The upper end usually retracts considerably, and in case of secondary suture, is identified by its bulbous enlargement.

If the nerve is injured in the forearm, the entire distribution of both its sensitive and its motor branches in the hand will be affected. The middle of the palm (palmar cutaneous branch), the inner and outer aspects of the palmar surfaces of the thumb, the index and middle fingers, and the outer aspect of the ring finger (collateral palmar branches) will be deprived of sensation. The thenar eminence will be atrophied and the abductor of the thumb will be paralyzed. In suicidal or other injuries at the wrist one or more of the branches of this nerve may be divided. The most important of these is the external division of the trunk, which supplies the abductor pollicis, the opponens and half of the flexor brevis pollicis.

The guide to the nerve in the lower third of the forearm is the inner (ulnar) margin of the tendon of the flexor carpi radialis. The nerve-trunk emerges from beneath the flexor sublimis digitorum about one and a half inches above the annular ligament, where it runs parallel to the flexor longus pollicis. From this point it may be traced in either direction. If the external branch is divided, its digital end must be traced beneath the annular ligament and the abductor and flexor brevis muscles. If these are cut in the dissection, they are to be repaired by suturing.

Aseptic wound-healing must be secured in order to insure success, both of tendon and of nerve-suture.

FRACTURE OF THE FOREARM

Fracture of both bones of the forearm is less frequent than fracture at the lower extremity of the radius. In case it is produced by a fall on the extended hand it lies at a somewhat higher point or at the junction of the middle and lower third of the forearm. This indirect fracture is relatively frequent in children and is usually of the incomplete variety known as "green-stick" fracture. In the middle and upper third of the forearm, fractures are usually caused by direct force. The displacement is usually in the direction of the normal curvature of the bones of the forearm, being directed toward the dorsal surface. In some cases one bone is bent, while the other remains straight.

The **diagnosis** is not difficult. **Reduction** is effected by grasping the forearm above and below the fracture. In case of incomplete fracture (**infraction**) the fracture is often accidentally made complete by manipulation or designedly in order to insure redressment. Special care must be taken in the reposition to have the bones parallel; with the upper fragments in supination and the lower ones in pronation, the movements of pronation and supination are greatly interfered with (**rotatory displacement**). In this latter position the interosseous ligament becomes partly ossified and impairment of function results. Under no circumstances should the retentive apparatus make lateral pressure on the parts. For this reason a bandage should not be directly applied nor should a plaster-of-Paris dressing be employed. An anterior and a posterior splint sufficiently wide to prevent pressure laterally, and well padded, are the best dressing. These should be prevented from slipping by encircling adhesive plaster, the latter obtaining a grasp on the skin between the edges of the splints (Fig. 720). The posterior splint extends from slightly beyond the knuckles to the elbow. The anterior splint should reach from the middle of the palm to the elbow. The graduated compress formerly applied to prevent lateral approximation of the bones may be omitted. The forearm is to be put up in a position midway between pronation and supination, flexed at the elbow, and supported by a sling. When the fracture is above the middle of the forearm a molded internal right-angle splint should be used to immobilize the elbow-joint. This should be applied after the anterior and posterior splints are secured in position. The parts should be inspected sufficiently often to insure retention of the fragments in proper position. While it may be necessary to remove the splints earlier on account of the swelling, in any event they should be removed in the second week in order to correct any new displacement.

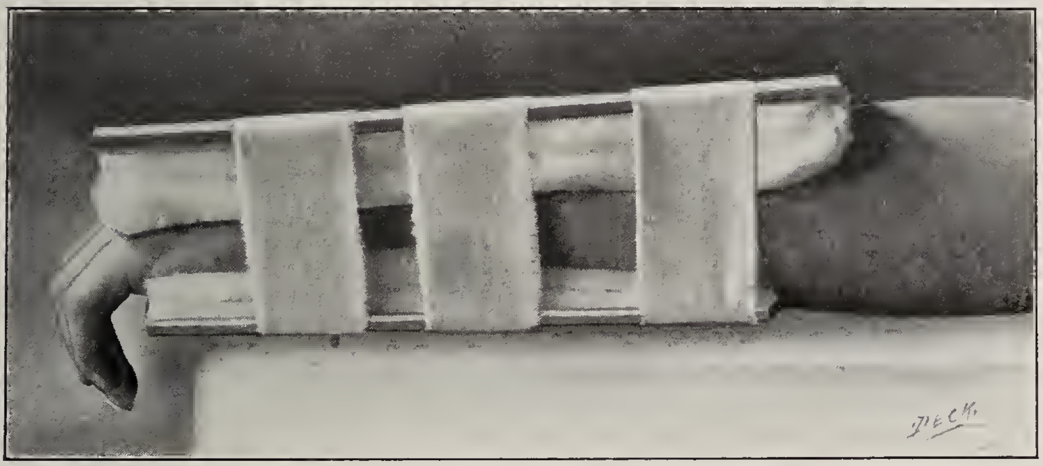

Fig. 720.—Splints Applied. Dressing for Fracture of the Forearm.

Ununited fracture occurs in this situation comparatively often. On account of this tendency care should be used in removing any portion of the fragments in compound fracture. In the treatment of the latter lesion, if the wound is so situated as to preclude the use of splints at first, the patient should be put to bed, the arm abducted, and weight and pulley extension employed, the arm resting on a pillow support or suspended. A long splint may be placed outside the dressings.

Fracture of the Shaft of the Ulna.—Fracture of the shaft of the ulna is almost invariably the result of direct violence. The displacement depends on the direction of the force which produces the fracture. This force is usually such as to cause considerable contusion of the soft parts; hence, unless the displacement is considerable, the **diagnosis** may be obscure. The symptoms will then consist of pain and tenderness at the seat of fracture. With the radius intact and no shortening present the only objective symptoms will be the absence of the normal condition obtained on palpation and the presence of crepitus when the fragments are moved on each other. Coincident dislocation of the radius is an important and not infrequent complication and should not be overlooked. There is marked displacement of the fragments of the ulna with unusual swelling at the elbow.

Reduction must be effected by pressure on the fragments. The lateral displacement must be overcome by pressing the thumb and fingers between the bones. The anterior and posterior splints employed in fracture of both bones of the forearm may be used, or a plaster gutter splint may be employed.

Fracture of the Styloid Process of the Ulna.—This is a not very infrequent complication of Colles's fracture, particularly in cases in which the hand is forced into excessive radial abduction. This movement puts the ulnar lateral ligament, which is inserted into the styloid process, on the stretch and breaks off its point. This fracture sometimes unites by fibrous tissue. Ankylosis between the radius and the ulna may occur, in which case the remedy is **resection of the lower end of the ulna.** The fracture may also occur from striking the styloid against an angular projecting body.

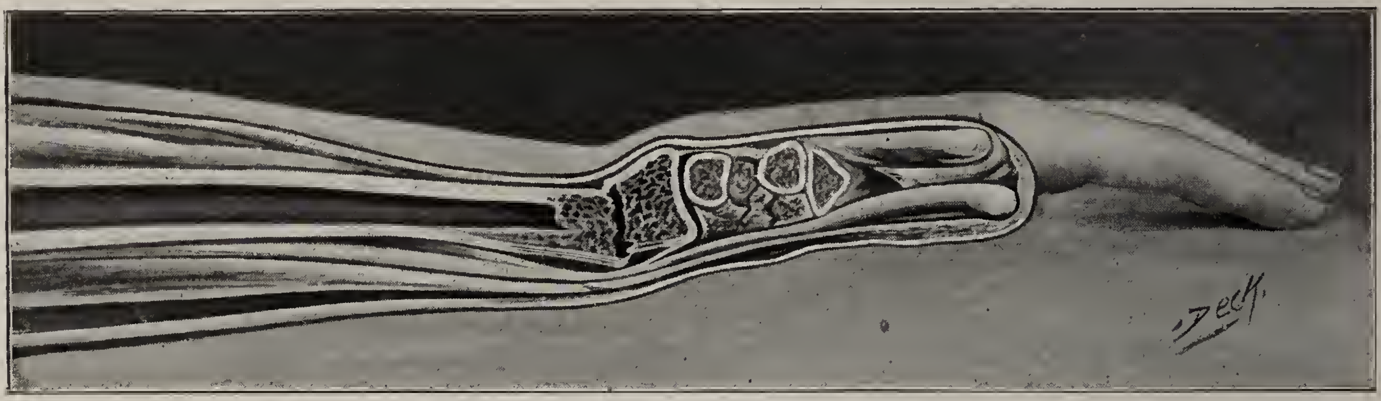

FIG. 721.—COLLES'S FRACTURE.

Compound Fractures of the Forearm.—These are somewhat rare. They may be followed by extensive suppurative processes both of the soft parts and of the bones. With vigorous antiseptic treatment the arm may be saved in the great majority of cases. Compound fractures of the lower end of the radius in military practice, particularly when due to the older patterns of firearms, frequently demand resection.

Colles's Fracture of the Radius.—Fracture of the head of the radius has already been described. **Fracture of the lower end of the radius,** generally known as **Colles's fracture,** was first described by Pouteau (1783), afterward by Colles (1814), and represents about one-third of all the fractures (Goyrand). It consists of a tearing off (fracture by avulsion) of the lower articular extremity of the radius by the tense and strong anterior carpal ligament with the hand in forced extension (dorsal flexion, Pilcher). The fracture and displacement of these fragments are aided by the forcible contact of the edge of the radius with the row of carpal bones. The injury results from a fall forward on the palm of the hand, the greater portion of the force being received on the base of the thumb. The line of fracture runs transversely from side to side about half an inch above the articular surface. The hand, together with the lower fragment, is forced toward the dorsum, the upper fragment being displaced anteriorly (Fig. 521). It sometimes happens, though rarely, that the mechanism of the fracture and the displacement of the fragments, are exactly the reverse of this, namely, the patient falls on the back of the hand, which is forced into strong palmar flexion. The lower end of the radius is torn away by the tense posterior carpal ligament, and the hand and the torn fragment are displaced anteriorly and the upper fragment posteriorly (Fig. 722). Impaction may occur in both varieties.

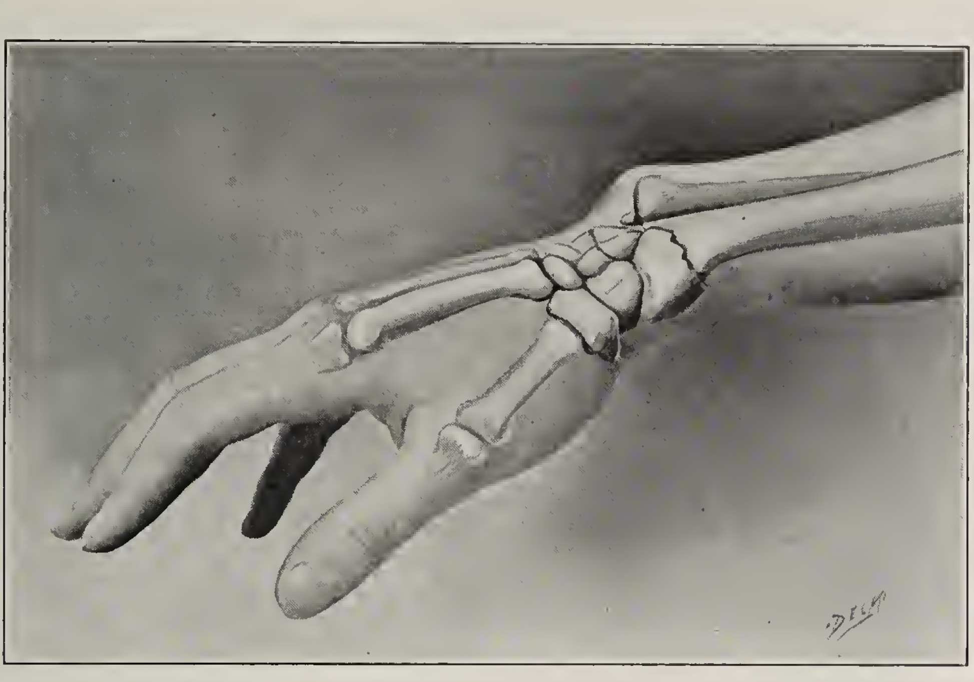

FIG. 722.—"REVERSED" COLLES'S FRACTURE OF ROBERTS.

The hand in Colles's fracture is slightly adducted and the lower end of the ulna unduly prominent, particularly on the palmar aspect. The former is due to the action of the pronator quadratus, and the latter to the shortening of the radius and the relatively greater length of the ulna.

This fracture may be mistaken for a simple sprain of the wrist; less frequently for a dorsal dislocation of the wrist-joint. The deformity is striking. An undue prominence is seen and felt on the dorsum in the region of or just above the wrist-joint, and immediately above it a depression. On the palmar surface, also above the wrist-joint, there is a prominence caused by the anterior displacement of the upper fragment. The attitude of the hand is striking and suggestive of the shape of a table-fork, and hence the deformity is known as the "silver fork" deformity (Fig. 723). The occurrence of abundant hemorrhage and extravasation may mask this peculiar attitude and lead to mistakes in diagnosis. The hand is powerless and can be neither

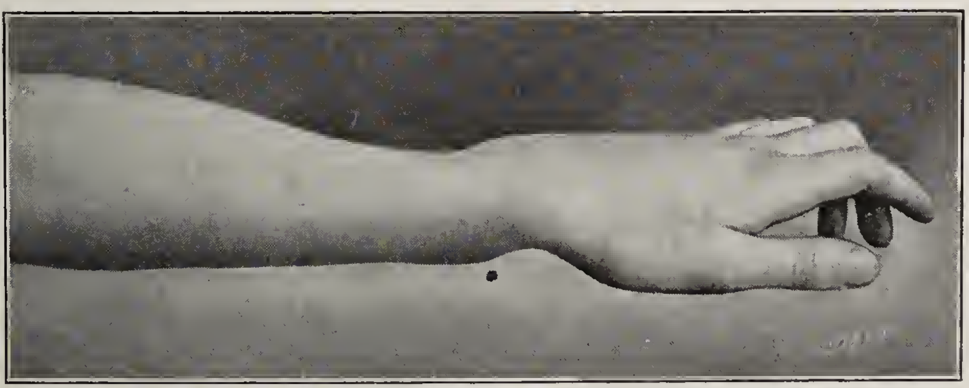

FIG. 723.—COLLES'S FRACTURE SHOWING THE CHARACTERISTIC DEFORMITY.

pronated nor supinated. In nonimpacted fractures crepitus and abnormal mobility can be made out.

In case of doubt between dislocation of the wrist-joint and fracture the relative position of the styloid processes should be noted. In the normal condition, as well as in the case of dislocation, the ulnar styloid is above a transverse line drawn squarely across the back of the wrist at the level of the lower portion of the radial styloid. In Colles's fracture the ulnar styloid is relatively lower and approaches the palmar surface. In other words, the entire forearm is shortened on the radial side and the ulnar styloid is forced downward and forward. If the swelling does not permit a due appreciation of these points of difference, while it is to be borne in mind that this fracture is exceedingly common and dislocation of the wrist very rare, still an attempt may be made to reduce as for a dislocation (see Backward Dislocation of the Hand, page 469). If the surgeon is in doubt as to whether the lesion is a fracture or a sprain, an *x*-ray examination will clear up the diagnosis. In the absence of this means of diagnosis the injury should be treated as a fracture.

The Treatment of Colles's Fracture.—The displaced fragments must be reduced under an anesthetic. In case of impacted fracture the parts are to be manipulated by backward and forward movements until mobility of the fragments is evident. Reduction is effected by grasping the hand as in the act of "shaking hands" and exerting forcible traction, combined with ulnar and palmar flexion at the same time that the fragments are pressed into line. Considerable force is often necessary to accomplish satisfactory reduction. The surgeon should persist in his efforts until this is effected. Once this is accomplished there is but slight tendency to redisplacement. A long palmar and a short dorsal splint, well padded and held in place by strips of adhesive plaster, the partly clenched hand being supported by a roller, are all that are necessary (Fig. 724). In applying the retentive apparatus the dorsal splint should be applied first, with a thin pad placed over the dorsum of the wrist. The anterior splint, with a pad of proper thickness over the palmar surface of the wrist and a portion of the splint cut away to clear the thenar eminence, is then applied. This immobilizes the fragments as far as this is necessary and leaves the fingers free to be extended or flexed. The splints are bandaged for the length of the shorter splint; the hand is to be but loosely bandaged, and that only to prevent the roll under the fingers from slipping out. In cases in which but slight displacement existed before the reduction, a simple broad

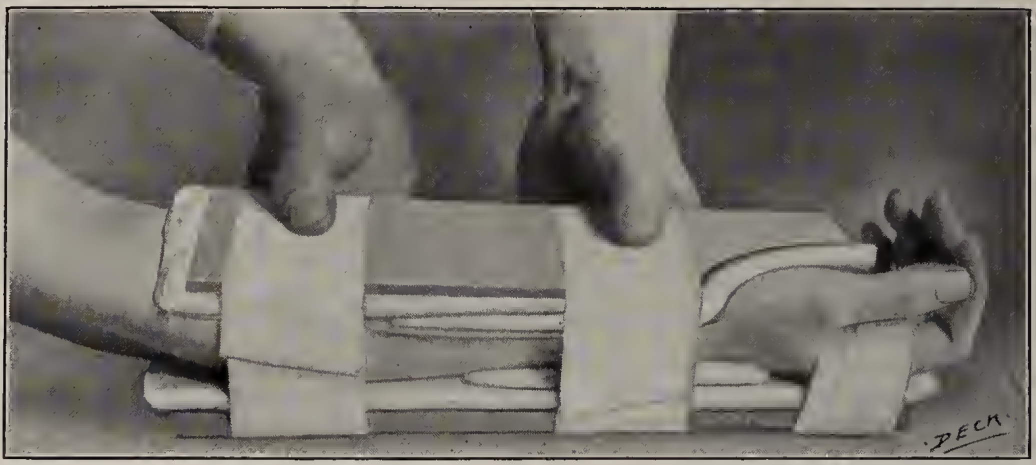

FIG. 724.—THE APPLICATION OF SPLINTS IN COLLES'S FRACTURE (AFTER SCUDDER).

band of adhesive plaster about the wrist, the lower portion of the forearm (not including the hand) being supported in a sling, is recommended. The most important part of the treatment is to secure early absorption of the exudate and the prevention of plastic fixation of the extensor tendons. This is best effected by early massage. The splints are to be removed at the end of a week, and massage employed and repeated daily.

That portion of the deformity relating to the lowering and anterior displacement of the styloid of the ulna cannot always be reduced. When the injury occurs in a growing child, this becomes more pronounced as time goes on. Should this impair complete flexion of the wrist at the ulnar side or produce abduction of the hand, resection of the lower end of the ulna may be performed. Should the lower end of the ulna and radius become fused in the reparative process (synostosis) as a result of simultaneous fracture of the ulna, resection of the lower end of the latter has been recommended (Lesser, Lauenstein). In the treatment of a "reversed" Colles's fracture the method of reduction and the position of the retaining splints are reversed.

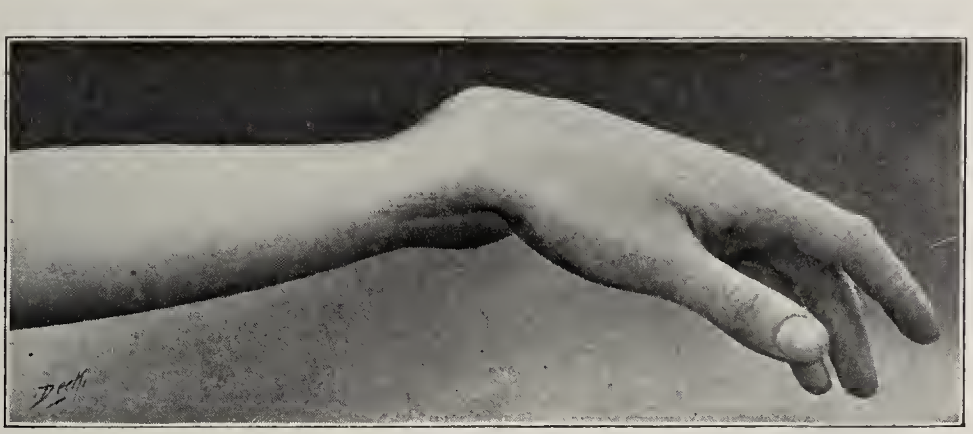

Fig. 725.—Backward Dislocation of Hand with Moderate Flexion.

Dislocations of the Hand.—Dislocations of the radiocarpal joint are exceedingly rare. In 24 cases collected by Tillmanns, the hand was dislocated backward 13 times and toward the palmar surface 11 times. In 10 the dislocation was complicated by fracture of the styloid process of either the radius or the ulna or both, or of the articular surface of either the radius or the carpal bones. These dislocations occur between the radius and the carpus and the displacement may be either backward or forward. In the **dorsal dislocation** (Fig. 725) the deformity bears a close resemblance to Colles's fracture. Like the latter, this dislocation occurs with the hand in a hyperextended position and is usually produced by a fall on the palm of the hand

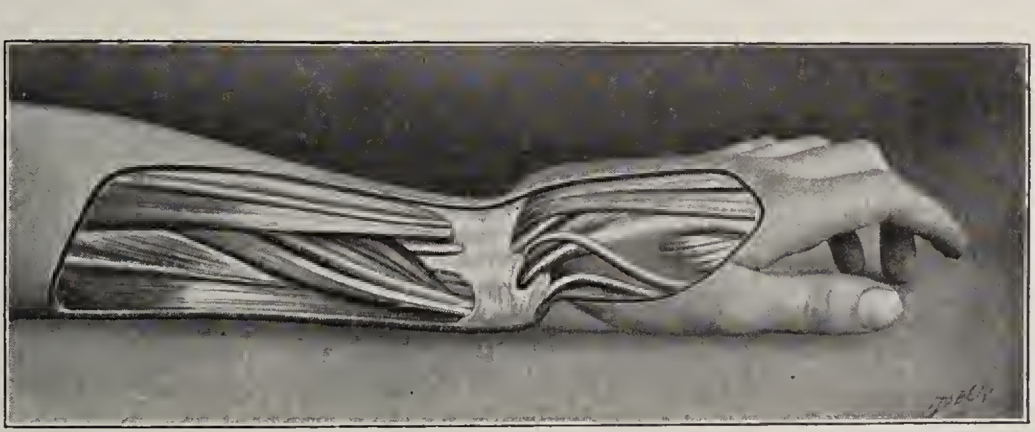

Fig. 726.—Backward Dislocation of the Hand without Flexion.

when the latter is in extension and abduction. The dorsal prominence is caused by the projection of the carpal bones and the palmar by the articular surface of the radius. The hand is usually in a more or less pronounced position of palmar flexion with the fingers slightly bent. This symptom, however, may be absent (Fig. 726).

In the **differential diagnosis** of dorsal dislocation and Colles's fracture the following points should be borne in mind: (1) In dislocation the styloid processes maintain their normal position with reference to each other, while their relative positions to the carpus are changed. In Colles's fracture the styloid of the radius is displaced, so that instead of occupying a position on a lower plane than that of the ulna it is elevated in the direction of the long axis of the forearm. (2) In dislocation more or less shortening is found on measuring the distance between the styloid process of the radius and the tip of the middle finger. In fracture this distance remains normal.

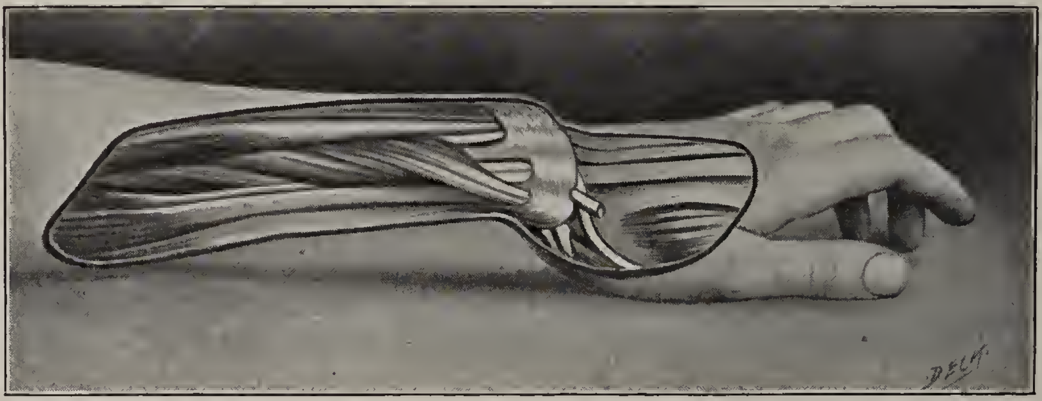

Fig. 727.—Forward Dislocation of the Hand without Flexion.

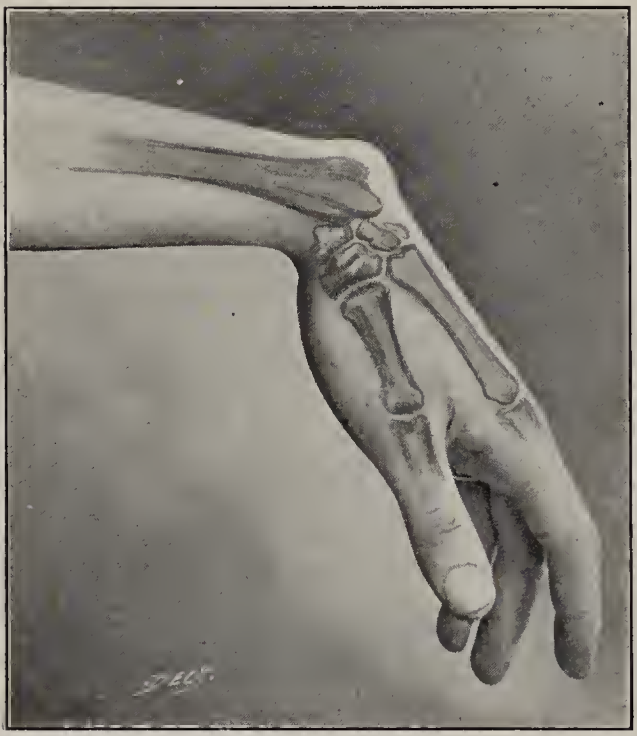

Fig. 728.—Forward Dislocation of the Hand with Pronounced Flexion.

Reduction should be made by means of extension followed by traction combined with direct pressure on the carpus.

In the **after-treatment** the hand is immobilized for a few days only on a splint, when passive movements, combined with daily massage, particularly of the sheaths of the tendons on the dorsum of the hand and wrist, must be carried out faithfully in order to obtain a perfect functional result.

Dislocation of the Hand Forward.—This dislocation usually results from a fall on the dorsum of the hand, the latter being in the position of palmar flexion. Violent rotation also may cause it. In Brainsby Cooper's case the accident resulted in a backward dislocation in one hand and a forward dislocation in the other.

The **symptoms** are the reverse of those arising from backward dislocation except that the palmar flexion may be more pronounced (Fig. 728). As in the case of the backward dislocation the symptom of flexion may be absent (Fig. 727).

Reduction is effected by traction and direct pressure on the carpus. In the after-treatment the same precautions in respect to a short period of immobilization and the early use of passive movements and massage, particularly with reference to the possibility that the hand may be permanently disabled by plastic exudation in the sheaths of the extensor tendons, are to be observed.

Compound dislocations of the hand are to be treated by the early application of antiseptic methods. Should suppurative inflammation of the wrist-joint occur, **atypic resection** is indicated.

Forced rotation of the hand may result in the loosening of the connection between the ulna and the triangular cartilage and produce an incomplete dislocation of the lower radio-ulnar joint. These accidents occur particularly in children as a result of lifting them by the hand. The hand is in the position of pronation and further pronation or supination is impossible. The treatment consists in making traction and at the same time rotating the hand into complete supination.

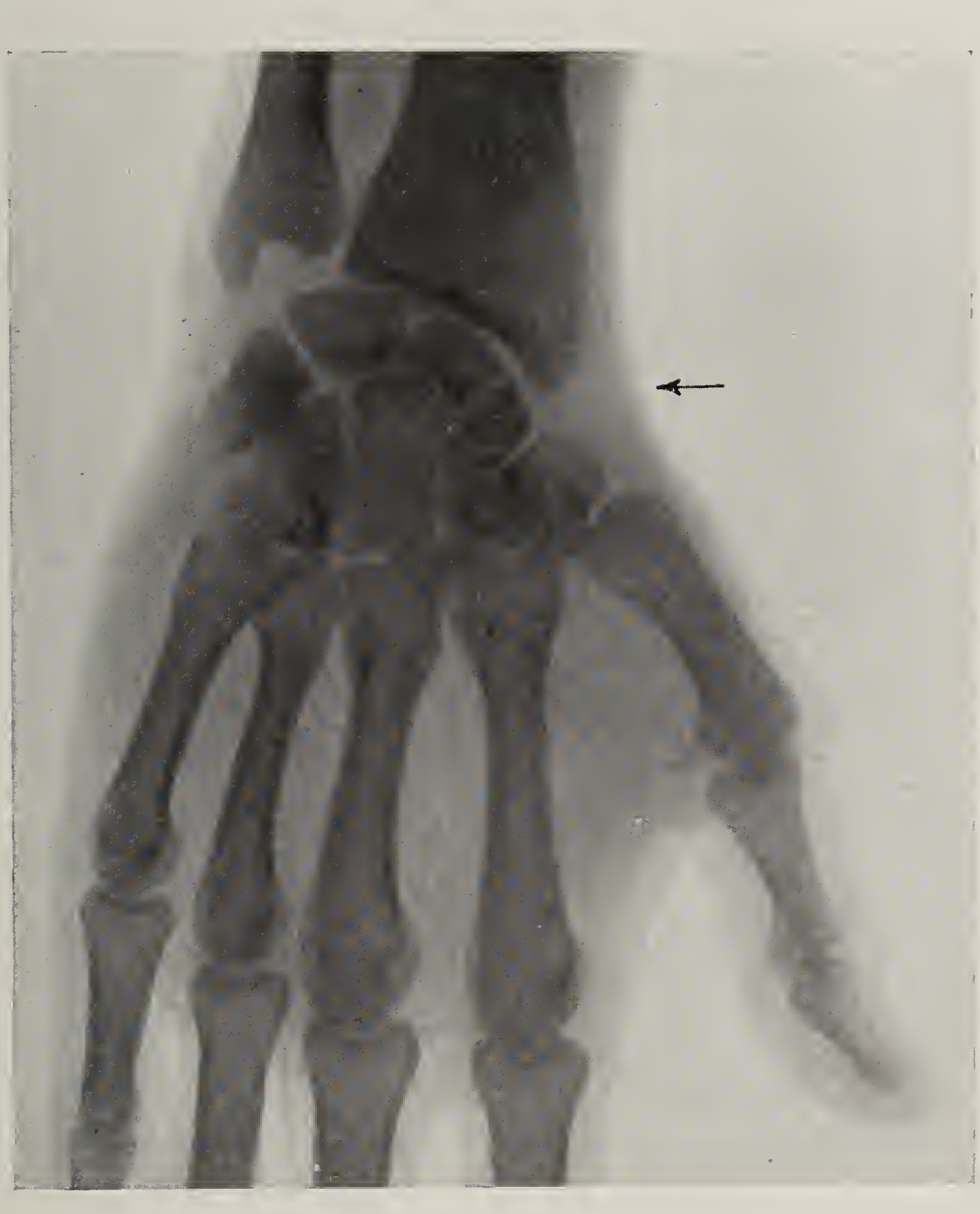

FIG. 729.—FRACTURE OF THE SCAPHOID.

Epiphysial separation of the lower end of the radius is a rare form of injury. It sometimes occurs in very young children and is due to a fall on the hand.

Fractures of the carpal bones occur, as a rule, as the result of great violence, as from a severe blow or a crushing force. They are mostly compound comminuted fractures. There is not usually much displacement (Fig. 729).

The symptoms are pain, swelling, localized tenderness, and sometimes crepitus. A simple bandage and the application of an ice-bag for the first few days will best meet the indications.

Dislocations of the Carpal Bones.—Dislocation of the **intercarpal** or **mediocarpal articulation,** *i. e.,* in which the entire second row of carpal bones is dislocated on the palmar surface of the first row, is extremely rare. Tillmanns was able to find but two cases in the whole literature, those of Maisonneuve and Malgaigne. The dislocation very much resembles that of the radiocarpal joint, with the exception that the relation of the lower end of the radius and ulna to the first row of carpal bones is not changed. **Reduction** is effected by traction and direct pressure.

The carpal bones most frequently dislocated are the scaphoid, the os magnum, the trapezium, and the semilunar. The os magnum is specially predisposed to **isolated dislocation.** In the flattened arch of the carpal bones, with its convexity toward the dorsum of the hand, the os magnum, like the astragalus in the foot, represents the keystone; this is easily forced out of its relations with the other bones with the arch in abnormal tension, as, for instance, in a fall on the flexed hand, the force impinging against the back of the hand. A fall on the closed fist, the force being transmitted through the metacarpal bone of the middle finger which is the most prominent, will also produce this dislocation.

Reduction of dislocations of the carpal bones is usually easily accomplished by longitudinal traction and direct pressure, aided by either palmar or dorsal flexion, according to the direction of the dislocation. In cases in which there is failure to reduce, as well as in **compound dislocation,** excision of the bone is to be practised.

Dislocation between the metacarpal bones and the bones of the second row of the carpus are somewhat more frequent than the corresponding dislocations of the foot. Usually, on account of the slight solidity of the dorsal ligamentous connections, the whole metacarpus or two or more bones of the same are dislocated on the second row of carpal bones. With the exception of the independent carpometacarpal joint between the first metacarpal bone and the trapezium, all these are plain joints united in a common articulation, in which dislocation takes place by extensive laceration of the ligaments and in which **reduction** is easily effected by simple pressure. **Retention,** however, is difficult, redislocation occurring easily. The application of a firm bandage with small compresses at the site of the dislocation is the proper dressing.

Dislocations of the carpometacarpal joint of the thumb are quite common; the forward dislocation is more common than the backward. They present a dorsal or palmar projection according to the direction of the dislocation. Reduction is effected by a movement of traction and direct pressure. Impairment of function of the joint for a long time is not uncommon.

Dislocations of the metacarpophalangeal joints are rare. The most frequent of these is **posterior dislocation of the proximal phalanx of the thumb** from violent dorsal flexion (Fig. 730). The head of the metacarpal bone is sometimes so tightly clasped by the abductor pollicis and the outer portion of the flexor brevis pollicis on one side, and the inner portion of the latter and the adductor pollicis on the other, between which structures it is forced as it passes to the skin, that this is said to offer an obstacle to reduction. The interposition of the sesamoid bone (Lücke, Faraboeuf), or of the tendon of the flexor longus muscles (Bardeleben) is also held responsible for difficulties in the reduction. The principal obstacle to reduction, however, as shown by experiments on the cadaver, is interposition of the capsule between the phalanx and the head of the first metacarpal bone (Roser). In at least one-third of the cases the reduction is effected with ease (Tillmanns). The thumb is brought into the position of hyperextension and the metacarpal bone held firmly while the proximal phalanx is pushed directly forward, which movement is immediately followed by palmar flexion. If the interposed portion of the capsule is not too long it will follow the phalanx. Otherwise it will remain on the articular surface of the metacarpal bone, and even if reduction takes place the dislocation will usually recur at once. Traction and forcible flexion will only increase the difficulties by bringing the sesamoid bone between the phalanx and the metacarpal bone. The application of a plaster-of-Paris bandage to prevent a recurrence of the dislocation has been suggested (Hueter). If difficulty is experienced in grasping the thumb with sufficient firmness in making these movements, a piece of tape tied about it in the shape of a figure-of-8 knot will be of assistance. Aseptic arthrotomy or resection of the head of the metacarpal bone should be resorted to in irreducible as well as in old dislocations.

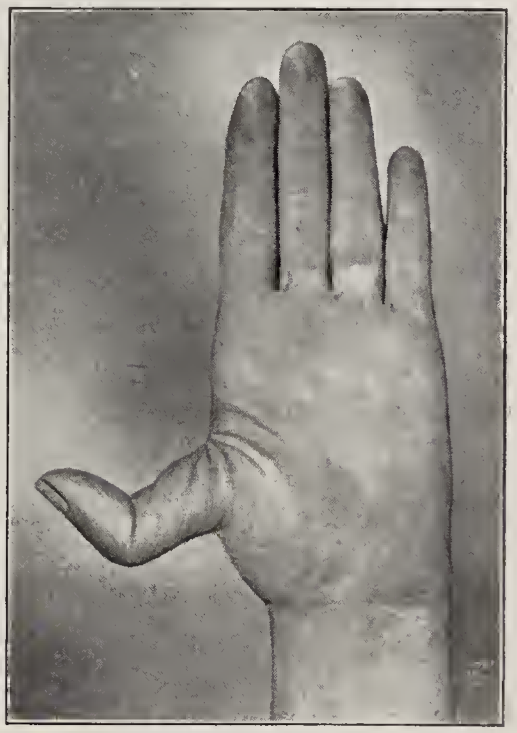
Fig. 730.—Dislocation of the Thumb Backward.

Fractures of the Metacarpal Bones and Phalanges.—**Fractures of the metacarpal bones** are due either to direct force, as blows, or to indirect force, the body falling on the clenched fist. The displacement is slight, this being prevented by the adjacent bones, except in the case of the first metacarpal bone; the mobility of this bone, however, serves to protect it against fracture. Function is not interfered with after repair, except in the rare cases of impaction of the shaft into the head. The application of a few strips of adhesive plaster about the metacarpus fulfils the indications.

Simple fracture of the phalanges is likewise rare, because of their mobility. Whatever small fragments are displaced are usually easily reduced, but are retained with difficulty. The broken finger is secured with splints of pasteboard and strips of adhesive plaster, or is simply bandaged to the adjoining finger.

Compound fractures of the metacarpal bones and phalanges occur very frequently and are generally the result of machinery accidents. Injury to the soft parts or to the bone may predominate.

Slash wounds, such as are received from hatchets, etc., usually result in primary union. Sometimes the head of a metacarpal bone or of a phalanx is completely severed. In that case it had better be removed, for the reason that, while it may heal satisfactorily, yet ankylosis of the corresponding joint will result from the reparative callus, requiring a resection finally. It is better therefore to treat the case by resection in the first place.

Splintered fractures sometimes require the removal of separate fragments, care being taken to preserve the periosteum, the shape of the finger being preserved as closely as possible in order finally to obtain relatively perfect restoration.

Amputation of a finger should never be performed for injury to the bone alone; only simultaneous and extensive injuries to the soft parts, and particularly to the tendons, will justify such a procedure. Above all things, the entire thumb should never be amputated except under the most dire stress of circumstances. The great importance of saving even a small portion of this member cannot be overestimated. An ankylosed thumb and index-finger are much better than none at all; but in the case of the other fingers amputation is sometimes advisable, owing to the fact that when healing is completed, a stiff finger may be in the way in certain occupations. If but one finger can be saved, and this, from the character of the injury, must be immobile, it is better to permit healing to take place with the finger partly flexed, since it will be of greater use in this position.

Injuries of the Soft Parts of the Hands and Fingers.—Punctured wounds of the hands and fingers are very frequent. They are of special importance when needles, splinters of glass or wood, etc., remain behind as foreign bodies. Such foreign bodies, if aseptic, may be healed in, but their presence gives rise to pains during movements. Finally, **tetanus** may have its origin in these wounds. Foreign bodies should be removed as soon as possible, the wound being enlarged for this purpose if necessary.

Incised wounds of the hands and fingers may easily injure important blood-vessels, nerves, and tendons. As a rule, the nerve branches on reaching this region are so small as to render impracticable their union by suture. The median nerve, however, if injured in the metacarpal region, must be sutured. The **ulnar nerve** is still more important, with its superficial sensory and deep motor branch. Movements of the fingers are greatly impaired by paralysis of the interossei and lumbricales muscles from division of this branch of the ulnar nerve. Fortunately its deep situation protects it from injury in most cases.

The **long flexor and extensor tendons** of the fingers are frequently divided in punctured and incised wounds. The ends of the flexor tendons usually retract in their sheaths considerably. In the case of the extensor tendons, this is not so marked, for the reason that these are situated more superficially and there are more bands of surrounding connective tissue which tend to prevent retraction. **Immediate suture** is the imperative rule in all cases of division of tendons, provided the wound comes under the surgeon's care while it is still fresh and aseptic. Otherwise secondary suture must be performed both in these cases and in those in which impairment of function after healing impels the patient to seek the surgeon's aid. The synovial sheath of the tendon is exposed, the stump identified and brought down and united with the other end. Should it be found impossible to bring the upper end down to proper approximation with the lower, **tendoplasty** must be performed. This is done by cutting one or both of the stumps across for about one-half of their breadth and at the proper distance from the end, and then splitting them longitudinally toward the end of the stump for a sufficient distance to permit the split portion, on being reflected, to reach easily to the other end (Fig. 731), when it is sutured.

The prognosis of **contused** and **ruptured tendons** is not so favorable. Not infrequently it becomes necessary to amputate because of the extensive injury to these important structures. The thumb and index-finger should be preserved in any event, even if they have lost their tendons.

Finger-tips and even large portions of fingers, when they are completely severed and have clean-cut surfaces, have been restored and sutured with success. This method may be tried if too long a time has not elapsed since the injury.

Injuries of the Vessels of the Forearm and Hand.—In the lower third of the forearm the **radial and ulnar arteries** lie so superficially that they are easily injured. Of these, the radial artery, from its almost subcutaneous situation, is more frequently endangered than the ulnar. Compression is unsatisfactory in many instances, and, in case of septic complications, is liable to be followed by secondary hemorrhage, in which case ligation of the vessel trunk in continuity may be necessary.

Deep punctured wounds in the middle of the forearm sometimes involve the terminal branches of the **interosseous artery,** which is to be ligated locally. In case of secondary hemorrhage it will be necessary to ligate either the brachial artery in continuity at the bend of the elbow or the interosseous above its origin from the ulnar artery.

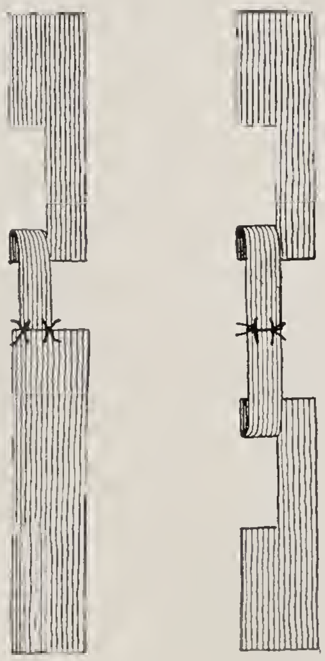

FIG. 731.—TENDOPLASTY WITH A TENDINOUS FLAP BRIDGING OVER THE SPACE BETWEEN THE ENDS.

Contused wounds of these arteries are often followed by provisional arrest of the hemorrhage; this may become definite by rapid granulation in case the wound remains aseptic. Secondary hemorrhage from contused wounds of these vessels is very rare at the present time. Should it occur, the application of a local ligature or ligation in continuity is indicated.

Venous hemorrhage from the subcutaneous veins on the back of the hand is usually easily controlled by elevation of the hand and the application of a bandage.

Injuries of the superficial and deep palmar arch are very important. **Primary local ligation of the superficial palmar arch** is scarcely ever practised; the hemorrhage was formerly arrested by compression or by forced flexion of the arm at the elbow. This, however, is an error, for the reason that septic conditions are very likely to follow the breaking down of coagula; secondary hemorrhages and other serious results follow. The wound may be in that portion of the arch which is supplied largely by the radial artery, as shown by arrest of the bleeding on compression of this vessel, in which case ligation of the latter in continuity is indicated. This failing, ligation of the ulnar is the next resource. Finally, as sometimes happens, the wounded portion of the arch is supplied by a branch from the interosseous branch given off from the ulnar, in which case the bleeding will continue and necessitate ligation in continuity of the brachial or even of the axillary artery.

Injuries of the hands from **toy pistols** are particularly liable to give rise to tetanus and should always be **treated as open wounds** for the reason that the special microorganism of tetanus is anaerobic, and hence cannot live in the presence of oxygen. At the same time suppuration must be avoided for the reason that pyogenic organisms consume oxygen, and in this manner the suppurative process favors the growth of tetanus bacilli. Asepsis, the entrance of air into the wound, and bromin are the best-known antagonists to the bacillus of tetanus. In all toy pistol wounds or wounds received from any agricultural implement, or about barns or stables, after the tissues that are likely to slough have been cut away, the wound should be thoroughly cleansed with peroxid of hydrogen followed by a hot solution of corrosive sublimate and painted with bromin, after which a light tampon of iodoform gauze and light antiseptic dressings (not occlusive) should be applied. An immunizing dose of tetanus antitoxin should be given.

Where there is no reason to fear the occurrence of tetanus, wounds of the soft parts of the hands are to be treated on general principles.

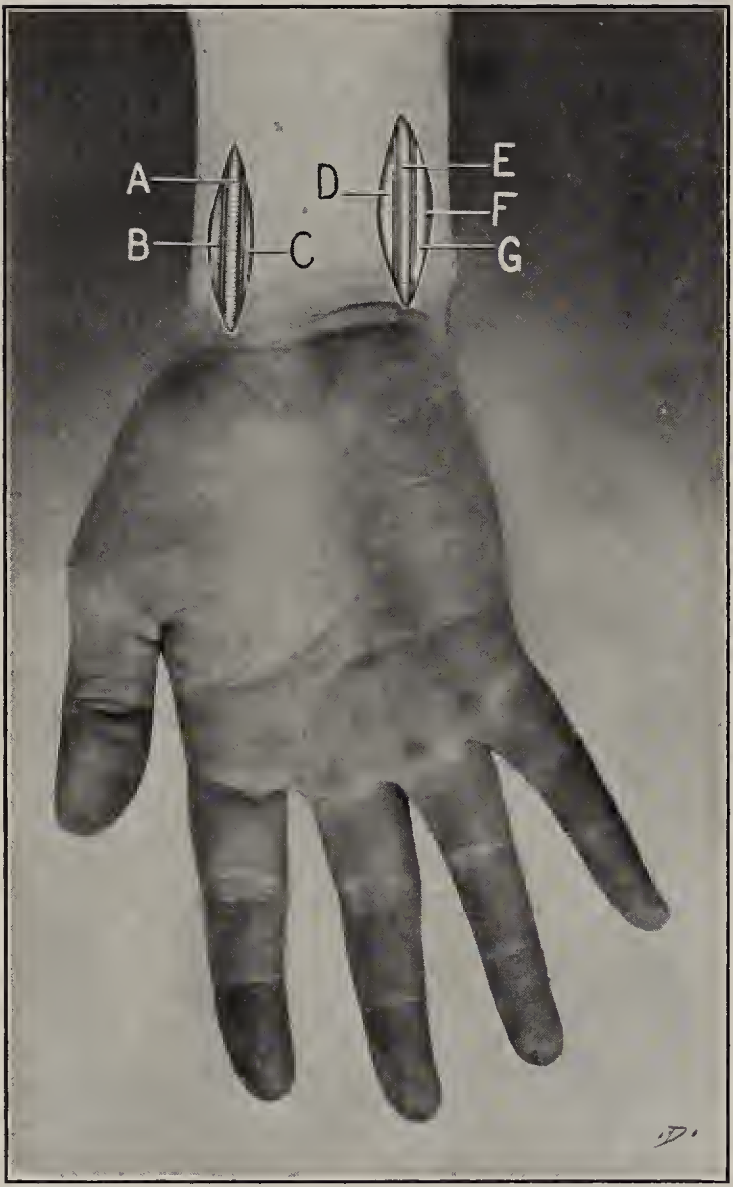

Fig. 732.—Ligation of Radial and Ulnar Arteries.

A, Radial artery; B, supinator longus muscle; C, flexor carpi radialis muscle; D, flexor sublimis digitorum muscle; E, ulnar artery; F, flexor carpi ulnaris; G, ulnar nerve.

Ligation of the Radial Artery.—This vessel is preferably ligated in the lower third of the forearm, where it lies between the supinator longus and the flexor carpi ulnaris, *i. e.*, in the first muscular interspace on the radial edge of the forearm. A superficial longitudinal incision reaches it at once; the fascia at this point is replaced by loose connective tissue. The artery is accompanied by two veins; the radial nerve lies toward the radial side (Fig. 732).

Ligation of the Ulnar Artery.—This vessel is exposed by an incision made in the first muscular interspace at the ulnar edge of the forearm, *i. e.*, between the flexor carpi ulnaris and the flexor sublimis digitorum. The fascia at this point is to be divided in the same line. This artery lies somewhat deeper than the radial artery. It is accompanied by two veins, as in the case of the radial, and the ulnar nerve lies to the ulnar side (Fig. 732).

Inflammatory Affections of the Wrist-joint.—Inflammation of the wrist-joint is a comparatively rare affection. **Gunshot wounds** give rise to typic **traumatic** inflammation and suppuration of the wrist-joint. In all wounds involving the joint the dangers of suppuration and of its spread are great, owing to the complex character of the joint.

Tuberculous osteomyelitis and **tuberculous synovitis** are most frequently observed. The disease may commence in the bone or in the synovial tissues. In any event all the structures of the joint finally become involved, constituting **tuberculous osteoarthritis of the wrist-joint.** Suppuration occurs finally and fistulous openings form.

The movements of the fingers are disturbed by lesions of the wrist-joint; in addition the functions of the latter are impaired. The freedom of the movements of the fingers depends on the position of the carpal joints. Involvement of the sheaths of the overlying tendons also occurs in tuberculous osteoarthritis. The tendons may become necrotic; at best adhesions take place and immobilize the tendons. In either case their function is destroyed and the corresponding fingers become useless.

The **treatment** consists in fixation of the joint, salt water bathing, and the internal use of carbonate of guaiacol and creosote; efforts to improve the surroundings of the patient in every way are useful. Local measures, such as injections of 20 per cent iodoform glycerin, employed to stimulate the growth of connective tissue and at the same time to obtain an antituberculous effect are indicated. The injections should be made below the ulnar styloid or at the sides of the extensor tendons. The method of passive congestion induced by elastic constriction (Bier) should also be employed. In more advanced cases the fistulous openings are to be enlarged and the parts thoroughly curetted. Resection of the wrist-joint, more or less atypic in character, is frequently required, however, even in the most favorable cases. This is particularly true in cases occurring in childhood and early youth. In cases sufficiently far advanced to require typic resection this should be reserved for those who are otherwise in comparatively good health. In general it will be found that atypic resection will suffice for the young and that amputation may well replace typic resection in those in more advanced years.

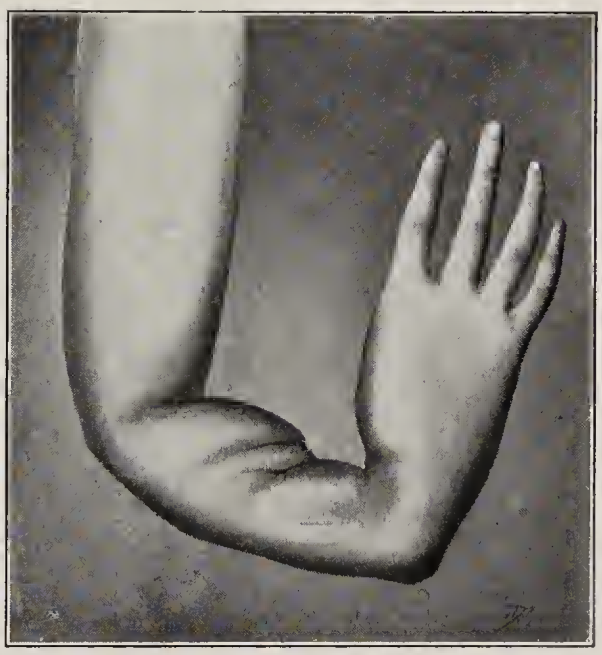

Fig. 733.—Clubhand with Absence of the Thumb (after Voigt).

In case of traumatic suppuration incision and drainage are rarely sufficient and resection enables the patient to escape both the long and tedious reparative process and the risks of final loss of the hand, giving also a better functional result in the end.

Contractures of the Wrist-joint.—These may arise (1) from inflammatory affections of the wrist-joint, from fractures of the lower end of the radius, or from polypanarthritis (arthritis deformans); (2) from paralytic affections of opposing muscles; (3) from destruction of the superficial structures by burns. In congenital contracture or **clubhand** (Fig. 733), the condition somewhat resembles clubfoot. It always depends on defective development of the bones of the forearm, particularly of the radius, which is sometimes absent, together with the thumb. The hand is in radial abduction and is strongly flexed on the forearm. In very rare instances the ulna is either wholly or partially missing, in which case the corresponding portion of the hand is also absent, the latter consisting only of the thumb and forefinger. The tendons and muscles are adjusted in size to the malposition.

In cases of contractures of the carpus, correction under anesthesia and orthopedic apparatus may improve the condition. Resection may be useful if the function of the tendons has not been destroyed.

Inflammatory Affections of the Dorsal Surface of the Fingers and Hand.—Furuncles are somewhat common on the back of the hand and fingers, specially in anatomists and surgeons who come in frequent contact with septic material. Wet antiseptic dressings, early incision, and the use of the curet are indicated.

Burns and frostbites are sometimes observed in this region. A venous stasis followed by a low grade of inflammation (dermatitis congelationis) sometimes develops as a result of repeated exposure to cold. Small exfoliations of the skin, or small blisters which may open, constitute the condition known as **chilblain** or **erythema pernio.** The ulcerated surface which may follow the opening of the bullae is slow in healing on account of the venous stasis. The immersion of the hands for quite a long time in lukewarm water, followed by bathing with oil of turpentin, and in addition the usual treatment of ulcers is to be recommended. The burning and itching sometimes occurring in simple erythema that is due to the same cause but is without the formation of blisters are best remedied by the local use of a mixture of one part of tincture of cantharides and five parts of soap liniment.

Inflammation of the soft parts of the fingers and hands often originates from small open wounds. The degree of inflammation will depend partly on the virulence of the invading septic microorganisms and partly on the susceptibility of the tissues. The difference in the latter respect between the dorsal and the palmar surface is striking. In the dorsal region the subcutaneous connective tissue has long fibers and is but loosely applied to the inclosed structures, the phlegmonous inflammation spreading readily as a result of this. The inflammation follows the subcutaneous connective tissue, as well as that surrounding the tendons with which it is in close connection. The palmar connective tissue, on the contrary, has short and rigid fibers, which pass vertically from the surface of the skin to the deeper parts; in the metacarpal region these pass to the palmar aponeurosis and at the fingers to the synovial sheaths of the long flexors. This disposition of the connective tissue intercepts the course of inflammation in this region, and the affection known as **panaris, whitlow,** or **felon** results (*vide infra*).

In **dorsal phlegmon** the affection runs a comparatively mild course, attended by low fever. The extensor tendons rarely become necrotic, though they are bathed in pus. The vessels which nourish the tendons are not subjected to great pressure, for the reason that greater space is afforded for the diffusion of pus in the adjacent loose connective-tissue spaces. Inflammation in this region, however, is frequently **complicated with lymphangitis** and **erysipelas.** As the inflammation extends to the carpal region it meets the six synovial sheaths of the extensor tendons lying close beside one another. Profuse suppurative inflammation may occur in all these tendinous sheaths, but as a rule they are attacked by a simple serous synovitis, the erysipelas and lymphangitis extending through the medium of the skin to the forearm.

Traumatic hemorrhage in the sheaths of the extensor tendons at the back of the wrist is due to contusions. Fluctuating swelling is noted, extending from the base of the second and third metacarpal bones to the lower edge of the radius. The treatment consists of immobilization with a short palmar splint, and moderate pressure. Absolute rest must be given to the injured parts.

Serosynovial effusions in this region are most frequently met with in the sheaths of the tendons of the extensor communis digitorum and the extensor carpi radialis longior and brevior; they occasionally occur in those of the extensor muscles of the thumb. They have their origin in traumatic effusions and in extension of inflammation from dorsal phlegmons. They are best treated by compression and massage.

Effusions are sometimes observed in the **large bursae of the flexor tendons at the palmar surface of the wrist.** They are characterized by the appearance of the effusion partly above and partly below the annular ligament of the wrist-joint. On compressing either of these the other fluctuates perceptibly.

Tendovaginitis crepitans occurs in the sheaths of the extensors of the thumb and results from the continued and excessive use of one group of muscles; it occurs in certain classes of workmen. Rest, inunctions of mercurial ointment, and massage are useful.

The extensor tendons sometimes become the seat of gonorrheal and syphilitic affections.

Disturbances in the free play of the extensor tendons are almost always due to adhesions following dorsal phlegmons and are to be treated by means of passive methodic flexion movements, massage, lukewarm baths, and gymnastic exercises.

Small bursae mucosae, in which serous effusions may develop, sometimes form on the dorsal surface of the phalangeal articulations in laborers; hygromas with solid roundish swellings may result from these.

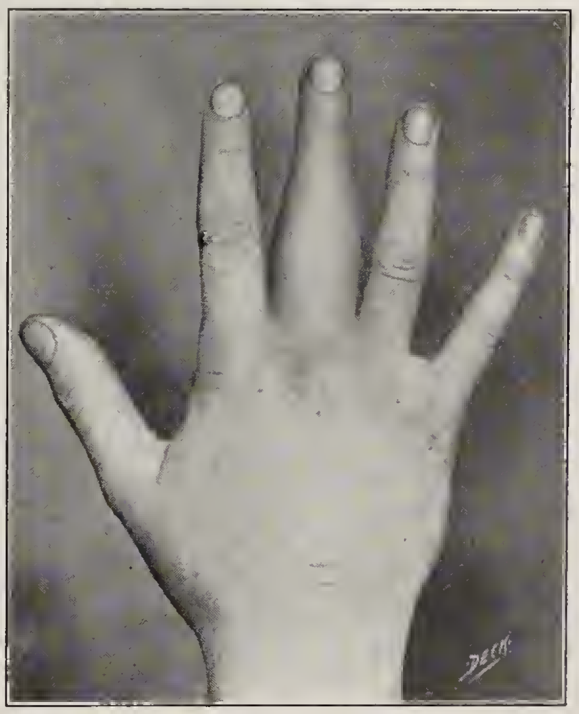

Fig. 734.—Spina Ventosa.

Inflammatory Affections of Metacarpal and Phalangeal Bones.—The medullary portions of the metacarpal and phalangeal bones are most frequently affected either by **tuberculous osteomyelitis** or by **congenital syphilis.** The name **spina ventosa** has been given to the affection. The bone thickens from the medullary substance, the periosteum taking but little or no part in the commencement. The swelling is almost insensitive in the beginning and recovery may take place in the course of weeks or months. Relapse may occur. In less favorable cases the "bottle-shaped" (Fig. 734) enlargement may break down after reddening of the skin, and fistulas, caries, and necrosis of the bone follow. The clinical picture in tuberculosis and syphilitic cases is very similar. In the latter the joints are only rarely affected primarily, though in both affections invasion of the articulations from the bone or soft parts may take place.

The fistulous openings may discharge for a long time, until a sequestrum is discharged or removed. If there is but slight involvement of the surrounding soft parts, nature's efforts in this respect may suffice. Conservative treatment is indicated before the formation of fistulas. General strengthening treatment and such local measures as inunctions of mercurial and iodin ointments may be employed. The probability of infection of the tendinous structures in particular will impel the surgeon to interfere operatively after fistulas have formed. This will consist of free incision and curettage of the bone cavity, subperiosteal resection of the diseased portion of bone if in the metacarpus, or, in the case of a finger, amputation well up in the metacarpal region. With secondary involvement of the joints of the fingers the latter course is indicated without question.

Inflammatory Affections of the Palmar Surface of the Fingers.—**Panaris, whitlow,** or **felon** is a traumatic inflammation arising from slight rents in the epidermis, with subsequent infection invading the papillary body and the subcutaneous connective tissue. It is an acute inflammation with the rapid development of suppuration, in which the connective tissue becomes rapidly necrotic. The inflammation is at first confined to the soft parts of the palmar surface. It may pursue a course finally resulting in extensive suppuration, followed by destruction of the functions of the fingers and perhaps of the entire hand.

The peculiar arrangement of the short rigid fibers of the connective tissue, while it prevents rapid spread of the infection, causes **intense pain** by constriction of the nerves, **necrosis of the involved connective tissue** by strangulation of the vessels, and directs the course of the inflammation into the deeper structures by their vertical course inward from the papillary body. Here the inflammation **invades the sheaths of the flexor tendons,** attacks the periosteum of the phalanges, producing **suppurative periostitis** with consequent total necrosis of the bone. It may perforate into a phalangeal articulation with resulting suppuration and destruction of the joint. The affection may also invade the dorsum, either by extension laterally or by perforation, and give rise to a dorsal phlegmon. It frequently gives rise to lymphangitis and erysipelas, particularly in case of virulent microbic agents, with subsequent involvement of the lymphatic glands at the elbow and in the axillary space.

The most important of these affections is suppurative inflammation of the synovial sheaths of the flexors of the fingers, along which it may rapidly extend to the large synovial sheaths of the flexors in the region of the wrist. The affection attacking the thumb and little finger is most serious in this respect, the flexor of the thumb possessing a long sheath continuing to the carpus below the annular ligament, and the flexor of the little finger frequently communicating with the common carpal synovial sheath. The suppuration may extend into the forearm as a subfascial or paratendinous phlegmon. The constitutional symptoms keep pace with the intensity and extent of the local processes. Thrombosis of the veins may be followed by migrating septic thrombi, pyemia, septicemia, and death. Though a fatal result is rare, impairment of function, with stiff, useless fingers, is certain to occur in every case in which suppurative inflammation of the sheath of a tendon takes place; necrosis of bone, with deformity, follows in any case in which the periosteum becomes extensively involved in the septic process.

The term **paronychia** (beside the nail) is applied to an inflammation about the finger-nail. It is really a subungual panaris, but is a much more innocent affection than that last described. The milder form is popularly called **"run-around,"** the more severe form **"felon."** The inflammation runs a rapid course and may form abscess, the necrotic nail being cast off by the inflammation of the bed of the nail, with the presence of granulations. A special form of the infection was supposed to attack scrofulous children (**onychia maligna**).

Treatment of Panaris and its Sequences.—At whatever stage this affection comes under the surgeon's care, the first and imperative duty of the latter is to **incise the parts freely** and expose the entire focus of infection. The incision may not be larger than a mere puncture a quarter of an inch long, for the primary focus is not usually large, but when the phalanges are attacked, it should be **deep,** to the extent of reaching the bone. In the case of the palm of the hand there may be some risk of injuring the superficial palmar arch, but even this risk must be taken, so disastrous are the consequences of not releasing the pressure and arresting the infectious processes. No attempt to "ripen" the suppuration must be made. Many fingers, hands, and even lives have been sacrificed by poulticing and delaying. The "ripening" under these circumstances means a harvest of necrotic bone, rotting tendons, and useless fingers and hands, to say nothing of the prolonged suffering and the dangers to life.

In case of doubt the most tender point is to be selected and the incision made. Only a drop of pus, or even none at all may escape, but the relief will justify the incision. If relief does not follow, another incision must be made. A probe wrapped with absorbent cotton and charged with a 5 per cent solution of chlorid of zinc, or a 95 per cent solution of carbolic acid, should be used to swab out the depths of the incision. The incisions must be kept open by a strip of gauze, or if sufficiently large, by a drainage-tube.

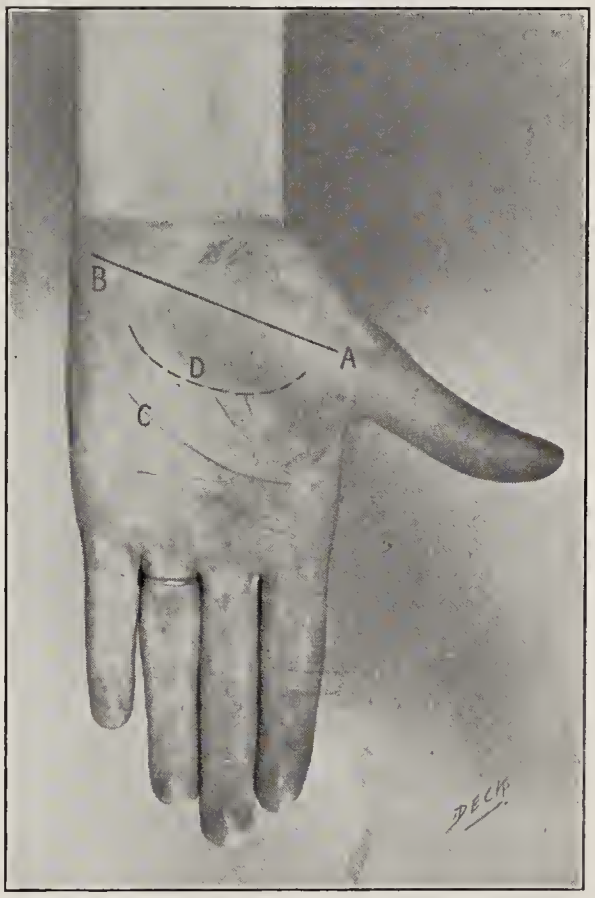

Fig. 735.—Superficial Palmar Arch. A, Metacarpophalangeal joint of the thumb; B, lower border of the pisiform bone; C, middle palmar crease; D, superficial palmar arch.

The incisions are to be made in the median line of the fingers and between the joints, and on the same lines in the palms of the hand. This avoids the nerves and vessels of the fingers and likewise reaches directly the invaded tendinous sheaths. **To avoid the superficial palmar arch** place the hand in full abduction, identify the metacarpophalangeal joint of the thumb, draw a straight line from this to the lower border of the pisiform bone. This line runs parallel to the middle palmar crease; the superficial palmar arch lies half-way between the line and the crease (Fig. 735). **The deep palmar arch is situated at a still higher point.**

In late cases the incisions must be longer, the deep parts curetted, and any sloughing connective tissue or tendons cut away. Suppurating articulations are to be resected and necrotic bone removed. Sometimes the entire middle or ring finger is gangrenous; amputation in the metacarpal region rather than at the metacarpophalangeal joint is to be preferred.

A suitable wet dressing consists of a 1 : 40 solution of carbolic acid with one ounce of tincture of opium added to each pint of the solution.

Contracture of the Finger-joints.—The most important consideration in these contractures relates to the condition of the tendons. With adhesions in the sheaths of the tendons the condition of the joints is of more importance, since, even if the motion of these were restored, the fingers would be comparatively useless.

In cases of threatened stiffness of the fingers from severe injuries it is important to provide for a useful position of the finger by avoiding the use of straight splints and employing such means of support during the healing process as shall prevent stiffening in the straight position but rather favor partial flexion. The adjoining uninjured finger may serve as a splint to which the injured finger may be secured, or, with proper dressings applied, the finger may be supported by a mass of gauze in the partially clenched fist and bandaged in this position. With fingers ankylosed in the straight position attempts may be made to correct the position under an anesthetic. Similarly, in the flexed position, correction may be attempted if the function of the tendons has not been impaired, with the hope of obtaining voluntary motions after a period of treatment by passive movements and massage. The half-flexed position during the healing process gives better opportunity for passive movements than either full extension or full flexion.

Habitual contractures are observed in those following certain occupations, such as coachmen. The constant flexion of the fingers leads to a shortening of the flexor tendons and palmar fascial bands, and to adhesion of the synovial folds within the joints. These are seldom treated surgically.

Cicatricial contractures are very frequent after burns and other injuries of the fingers and hand. When large traumatic defects of the skin exist, the skin transplantation method of Thiersch may be tried. The result, as far as restoration of function is concerned, is not very satisfactory. When applicable, the method of **transplantation of skin flaps with a pedicle** is to be preferred. The flap may be taken from the chest wall or other available region, according to the location of the defect.

Dupuytren's contraction is a spontaneous cicatricial retraction of the palmar fascia and its digital prolongations, with adhesions to the skin. According to Dupuytren, it is due to irritation of the tissues by hand work, the persistently flexed position of the hand favoring the retraction. It has been thought to be due to persistent forced grasping movements without pressure, as in grasping the bow in violin playing (Lossen's case). Atrophy of the adipose tissues in elderly people is said to favor it. Heredity is thought to exert an influence (König). It occurs without any discoverable cause and may have a relatively symmetric development when occurring in both hands (Fig. 736). In some cases there is an underlying constitutional condition, such as a gouty diathesis. A similar contraction has been described occurring as a congenital condition, due to atrophy and shrinkage of the skin (Gibney). Dupuytren's contraction may attack one or several fingers, usually the outer two. It begins most frequently on the ring or little finger as a small calluslike nodule. Interference with complete extension is noticed from the first; flexion of the fingers steadily increases, until in the course of time the fingers are firmly flexed and lie in the palm of the hand.

The nodule increases to a firm fibrous longitudinal band in the palm, which sometimes feels like cartilage. The tendons take no part in the contracture.

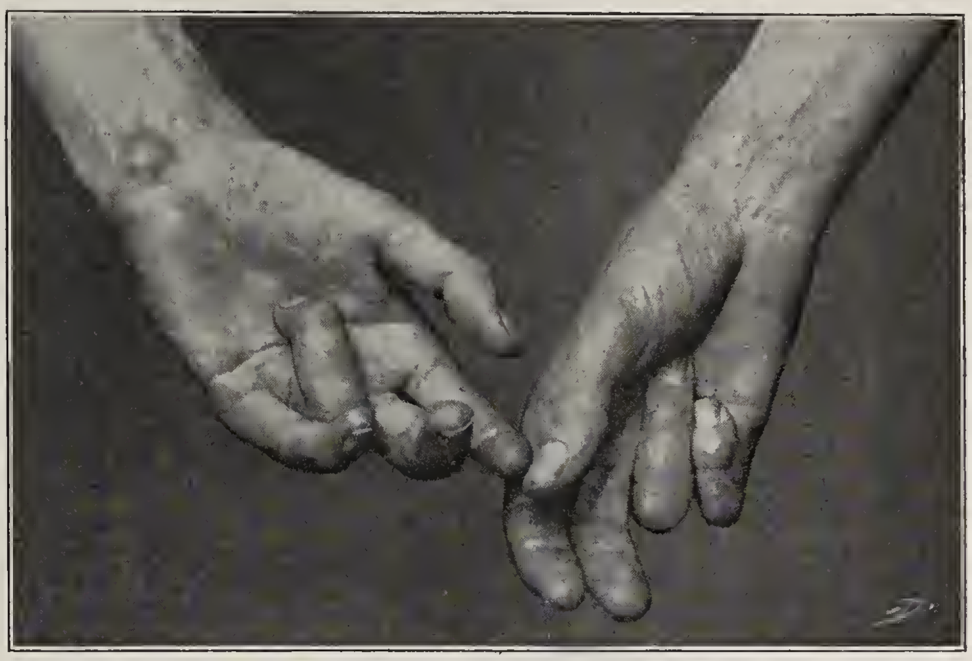

Fig. 736.—Dupuytren's Contraction.

Treatment.—Warm applications, massage, and passive movements may hold the affection in check, particularly if the occupation favoring it is abandoned. In fully developed cases only operative treatment is successful. Busch's method consists in turning down a triangular-shaped skin flap which shall include the indurated parts, the base of the triangle being toward the contractured finger or fingers, and dissecting away the palmar fascia and dividing all fibrous cords until the finger can be freely extended (Fig. 736). Extirpation of the fibrous cord, where this is well defined, with the attached skin is to be preferred. Two parallel incisions are made, one on each side of the fibrous cord for its entire length. These are joined at the two extremities. The intervening portion is carefully dissected out for the entire thickness of the palmar fascia, the edges of the incision being retracted in order to "cut under" somewhat and thus insure removal of all the diseased fascia until the finger can be extended. The edges are sutured and the finger dressed in the straight position. The success of the operation depends on strict asepsis and the early, persistent, and methodic use of massage.

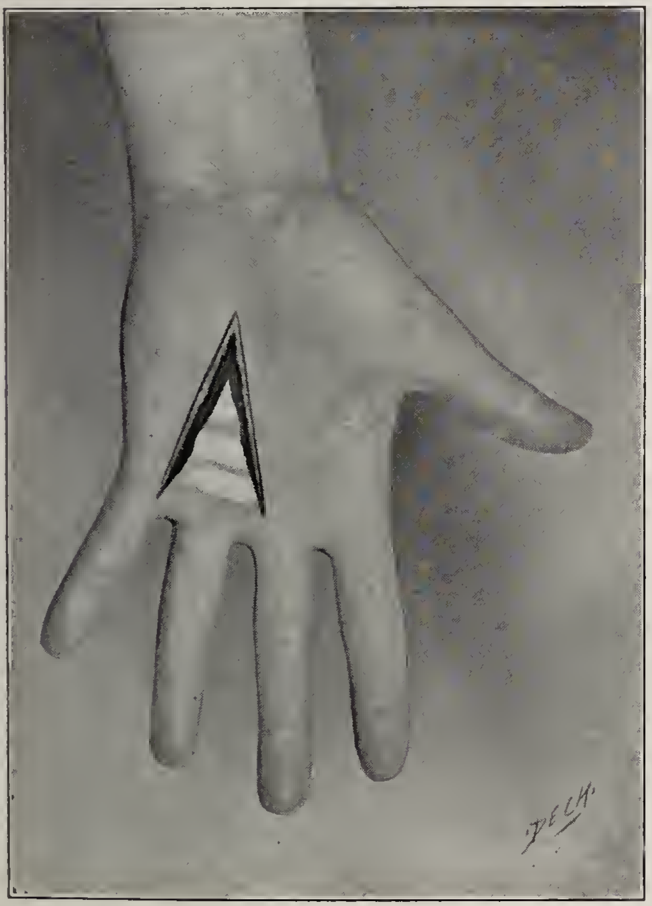

Fig. 737.—Busch's Operation for Dupuytren's Contraction.

"Trigger finger" is a peculiar affection in which, on flexion or extension, the finger is moved to a certain point and is there arrested, either requiring assistance from the other hand, or, when the obstacle is overcome by its own tendon, being released with a jerk, like the opening and closing of a pocket-knife, the movement of flexion or extension being thus completed (Notta, Nélaton). The jerk is sometimes accompanied by a cracking sound and often by pain. Menzel investigated this condition and found it to be due to a narrowing in the sheath of the flexor tendon, due to preceding inflammation, through which a thickened portion of the tendon passed with difficulty. He produced the characteristic jerk artificially in the cadaver. There may also be a free body in the sheath. Steinthal (1885) found another mechanism for the affection in an abnormally placed anterior attachment of the lateral ligament of the joint. König described a similar condition in the toe (1881).

The **treatment** of trigger finger consists in the use of massage and methodic passive movements. Operative treatment consists in opening the sheath of the tendon at the narrow point. If a free body is present it is to be removed. Otherwise the disproportion between the tendon and its sheath is to be overcome by splitting the sheath, closing the skin wound, and making early passive movements to maintain the patency of the sheath until a splice of new tissue fills in the gap in the sheath.

Occupation Spasms.—There are certain spasmodic affections of the muscles due to occupation. They are known as writers' cramp, piano-players' cramp, seamstresses' cramp, telegraphers' cramp, etc. These conditions are of interest to the surgeon only from the diagnostic standpoint. Their treatment belongs to the neurologist.

Paralytic contractures are flexion contractions; they may be either congenital or acquired. The acquired ones may arise from "essential paralysis" in young children or from injuries to nerve-trunks. **Crutch paralysis** occurs from the pressure of crutches against the brachial plexus in the axilla, which produces paralysis in individual nerves in the arm.

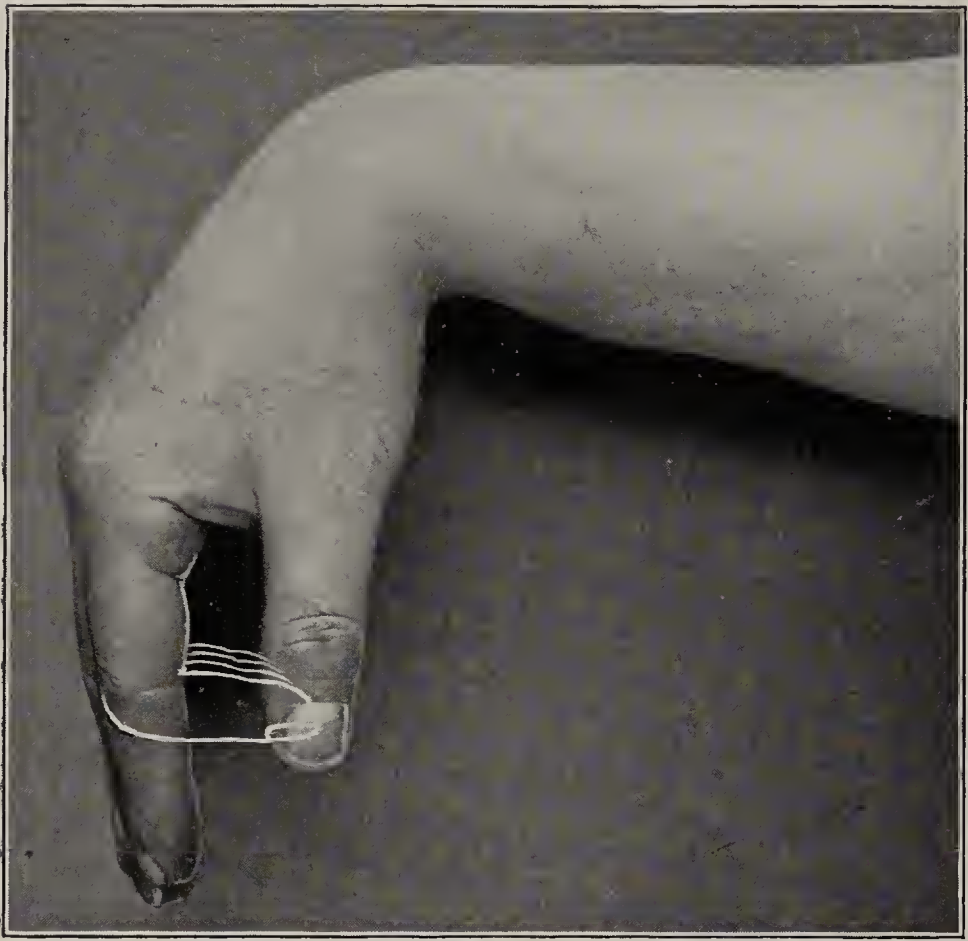

Fig. 738.—Wrist-drop.
The white lines show range of possible movements in paralysis of the musculospiral nerve.

The **musculospiral nerve** is most frequently injured by fractures of the shaft of the humerus involving the musculospiral groove, compound dislocations of the elbow-joint, and gunshot wounds. The movements of the fingers are specially impaired and there is present the peculiar position of the hand, occurring also in lead poisoning and known as "wrist-drop" (Fig. 738). The hand and fingers hang down in marked flexion; active extension is impossible except in the metacarpophalangeal joint, where the two proximal finger-joints can be extended, the muscles moving these receiving their nerve-supply from the ulnar nerve. Excessive pressure on the musculospiral nerve may produce the paralysis, such as leaning the head on the arm for a long time while in a drunken sleep, permitting the arm to hang over the operating table during an operation, etc. The **diagnosis** of musculospiral paralysis is based on an anesthetic condition of the skin in the distribution of the radial nerve (*vide infra*), loss of extension of the fingers at the metacarpophalangeal articulations, and the wrist drop. The last two phalanges can be extended, however, by the interosseous and lumbrical muscles. If the injury is above the supply to the supinator longus, the action of this muscle as a flexor of the forearm is lost. Supination is performed by the supinator brevis, however, and supination and flexion combined by the biceps. In musculospiral paralysis due to simple pressure the use of electricity is indicated and the function of the nerve is restored in due time. In other injuries involving division of the nerve, suture of the latter is indicated.

Injuries of the ulnar nerve are very important, owing to the functional nature of this nerve in movements of the fingers. It governs flexion of the first row of phalanges, extension of the second and third rows, and abduction and adduction of the fingers. The two points at which it is most commonly injured are at the elbow between the ulnar edge of the olecranon and the internal epicondyle, and in the lower portion of the forearm, where the nerve accompanies the ulnar artery. The clinical picture of injury of the ulnar nerve is striking, for, in addition to the loss of sensation in the little and ring fingers, the impairment of movements is characteristic of paralysis of this nerve. The closure of the hand as in "making a fist" is very defective and flexion of the first row of phalanges is only imperfectly performed. The impairment of extension is still more striking. The first row of phalanges may be extended, but extension of the second and third rows is impossible. In time the hand assumes the peculiar attitude known as the "claw hand" or "griffin clutch" of Duchenne (Fig. 739).

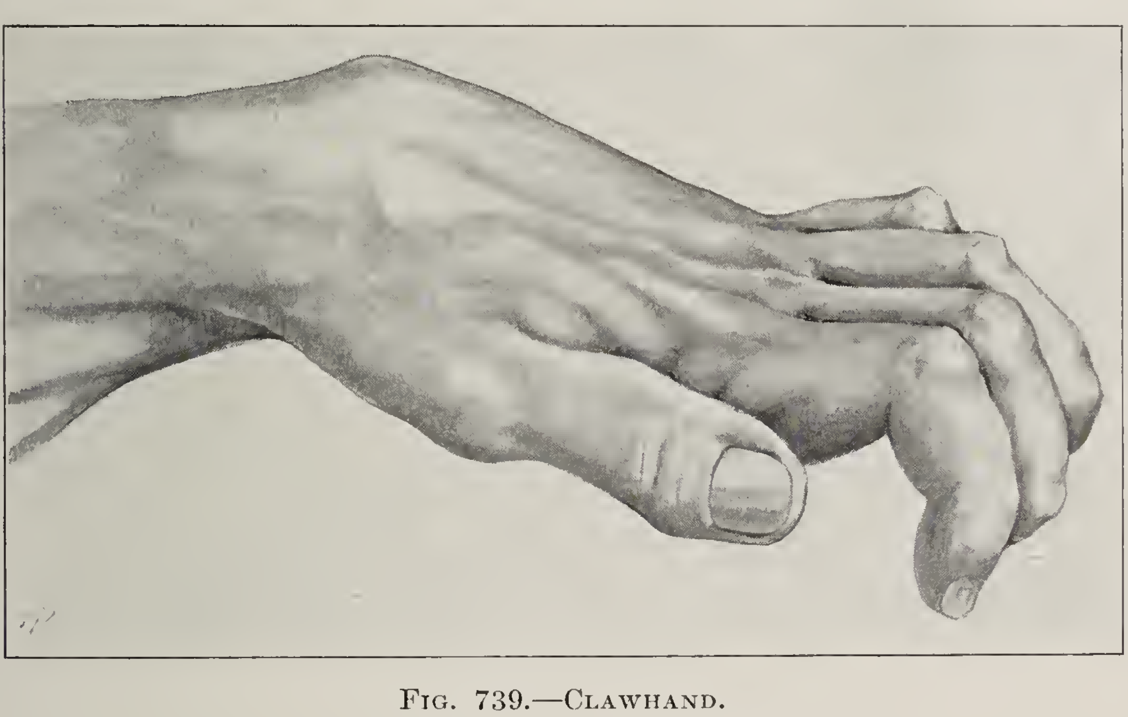

FIG. 739.—CLAWHAND.
Griffin clutch of Duchenne.

The **treatment** consists in suture of the nerve. In nonoperable cases an apparatus designed to retain a position of the joints midway between flexion and extension should be worn.

The **radial nerve** is sometimes injured just above the wrist. The only symptom is an anesthetic condition of a portion of skin in the metacarpal region and over the first phalanx of the thumb and forefinger.

Chronic Inflammation of the Skin of the Hand and Fingers.—**Anatomic lupus** is a chronic infectious inflammation occurring in anatomists and those brought in contact with cadavers and septic material. When the affection takes the shape of distinct nodules, it is called **anatomic tubercle.** Excision of the diseased tissue is the best remedy.

True **lupus** attacks the skin of the dorsum of the forearm and hand. It may take the exfoliative or the ulcerative form, in the latter case leading to extensive ulceration and radiating cicatrization. The treatment consists in the use of mercurial ointment, vigorous curetting with the sharp spoon, and, these failing, extirpation and plastic filling in of the defect.

The fingers are peculiarly affected in cases of **leprosy** or **elephantiasis Graecorum.** This is an endemic chronic disease occurring in Europe and Asia, particularly along the Mediterranean shores, and Hawaii. Its cause is the Bacillus leprae (Hansen). In the nodular form tubercles are scattered over the entire body, specially on the skin of the forearms and hands. The nodules are preceded by erythema and raised patches of skin. The disease is incurable.

Raynaud's disease or **symmetric gangrene** is a peculiar form of dry gangrene of the fingers, accompanied by hemoglobinuria and apoplectiform attacks. It is dependent on disturbances of the central nervous system involving altered innervation of the vessels and consequent spastic contraction. There is local syncope, local asphyxia, and finally local or symmetric gangrene. The treatment consists in improving the circulation; when gangrene is present, the parts should be protected against sepsis and amputation performed according to general rules.

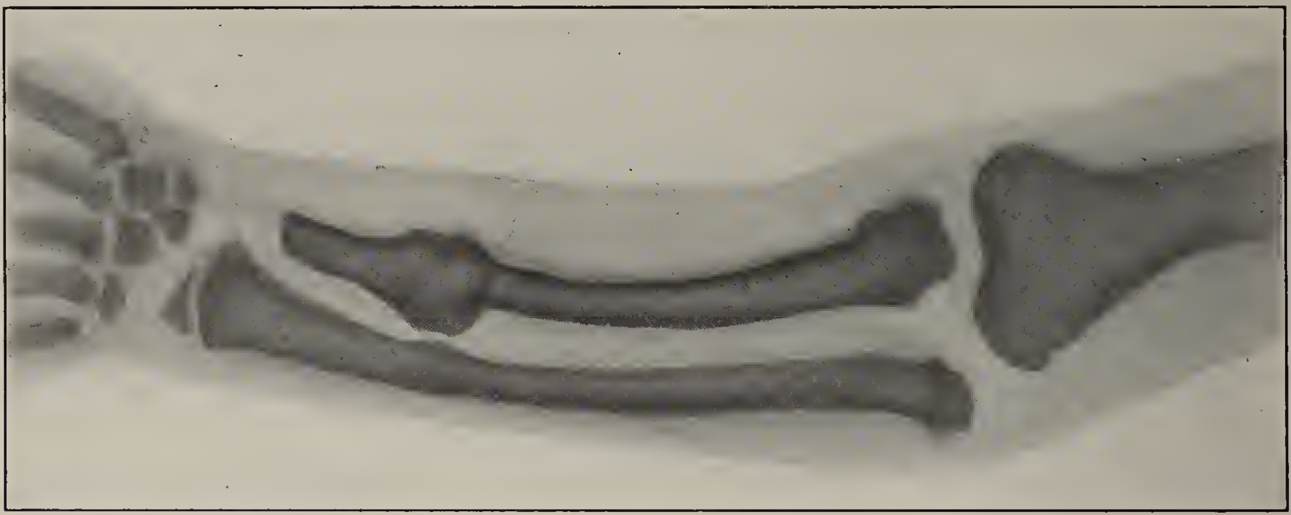

FIG. 740.—ARM OF RACHITIC CHILD.

Syphilitic affections of the fingers and hand are rather frequent. They are observed as **syphilitic indurations,** occurring in obstetricians and midwives; **syphilitic rhagades,** a combined hyperplastic and ulcerative affection of the skin between the fingers, occurring in secondary syphilis; **syphilitic dactylitis,** a fusiform swelling of individual phalanges, due to gummatous periostitis and osteomyelitis of the phalanges; **syphilitic onychia,** an ulceration in the bed of the nail; and finally **palmar psoriasis,** a thickening of the epidermis, with scale formation. Only palmar psoriasis is of syphilitic origin; the dorsal variety is nonsyphilitic.

The disease known as **rachitis** or **rickets** produces certain well-marked deformities in the long bones. These consist of exaggerations of the normal curves of the long bones and enlargement of the articular extremities, particularly of the lower end of the radius. Coincident enlargement in the lower third of the shaft of both the radius and the ulna may also occur (Fig. 740). In the surgical treatment of these curvatures properly applied apparatus may be employed during the acute stage, or while the bones are soft. Operative interference during this stage is useless; failure of union is frequent and recurrence of the deformity almost certain. After consolidation, however, osteotomy is indicated if the deformity is sufficiently great to warrant it.

Tumors of the Skin, Tendons, and Bones of the Hands and Fingers.—Small benign tumors of the papillary body of the dorsal surfaces are known as warts or **verruca vulgaris.** Their presence seems to be due to some uses to which the hands are put, since Virchow saw them on the feet of a man who was without upper extremities and who used his feet as hands. These growths are very rare on the feet. Their **treatment** consists of excision to the surface and the application of solid stick of nitrate of silver to the base. The twice daily application of salicylic acid and collodion (dr. j–oz. j) is said to cause their disappearance in time. Nitric, glacial acetic, or chromic acid, occasionally applied in very small quantities, will destroy them. They sometimes disappear spontaneously. The so-called "soft warts," *i. e.*, ulcerated warts, occurring in the interdigital spaces are sometimes very troublesome.

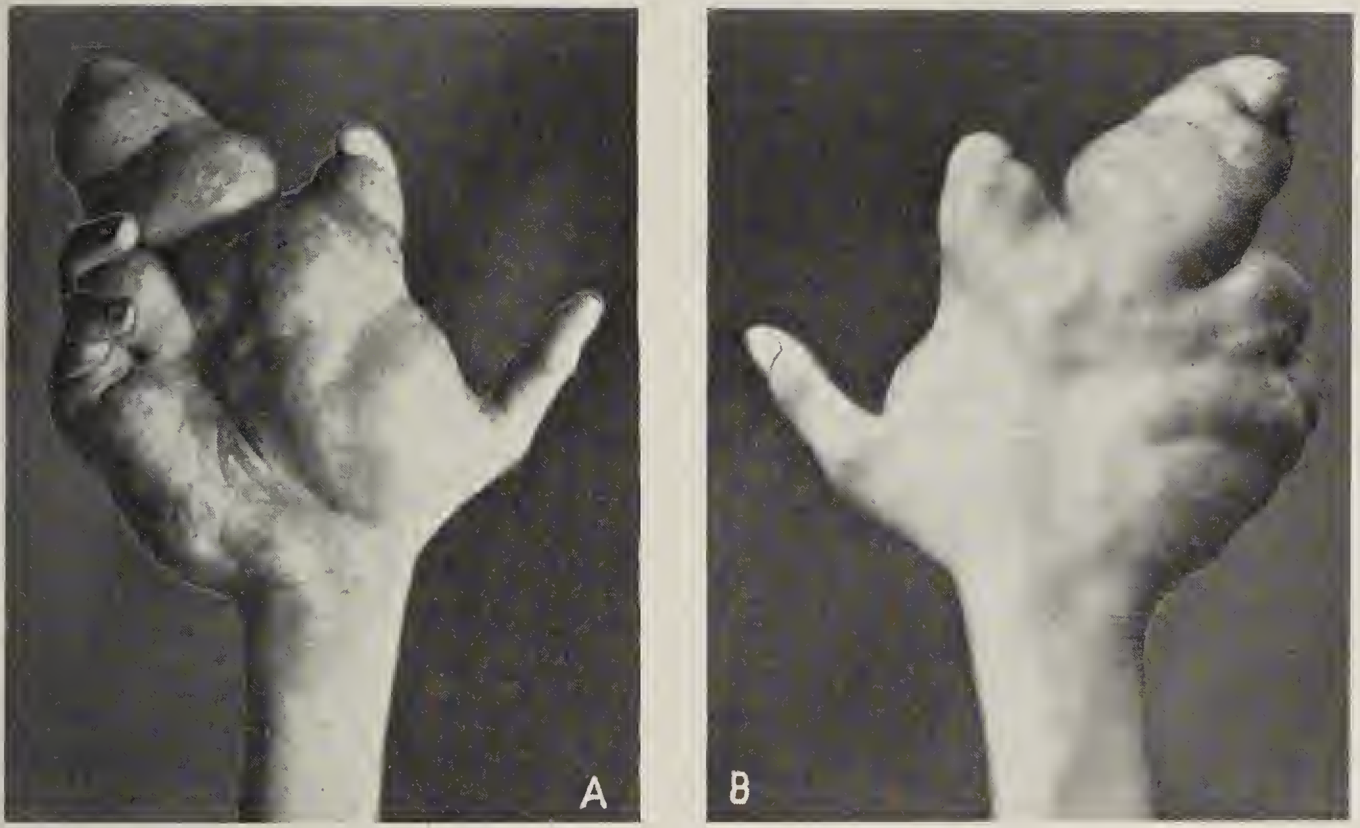

Fig. 741.—Congenital Cavernous Nevus in the Right Hand of a Boy Ten Years of Age. A, Palmar surface; B, dorsal surface (courtesy of Dr. L. L. Hill, of Montgomery, Ala.).

Callosities are hyperplastic conditions of the epidermis and are interesting surgically only because of the fissures which occur and which become the point of entrance of septic infection.

Cavernous nevi are found comparatively often on the hands and fingers, developing particularly in the dorsal subcutaneous connective tissue of the metacarpal region, near the large veins. Both hands may be affected (Fig. 741).

Cirsoid aneurism of the forearm and hand occurs but rarely. Thirty cases were collected by Mink (1885).

Lipomas in the subcutaneous connective tissue of the fingers are rare.

Sarcomas.—The bones of the hand and fingers are rarely the seat of sarcomas. In the cases reported the disease has sprung from the metacarpal bones and the phalanges and has been of the periosteal variety. Central sarcoma of the carpus is rare.

Epitheliomas are seldom observed in the hand and fingers, but are more frequently found on the dorsal surface of these parts than in other situations on the extremities. They sometimes have their origin in warts or cicatrices. Secondary glandular involvement in the axilla occurs early and grows rapidly, constituting the most dangerous feature of these cases. **Amputation** of the finger is called for. This is useless, however, unless the diseased glands are extirpated.

Simple ganglions of the synovial sheaths of the extensor tendons, more rarely of the flexors, are oval tumors varying in size from a pin to a walnut, with smooth surfaces and different consistencies, according to the tension on the sac containing the thick jellylike contents. The latter is mostly mucin, remaining after the absorption of the watery constituents of the contents. These tumors are more or less movable, according to the nature of their connections with the tendons. They do not communicate with the interior of the tendon-sheaths. They are most frequently found on the dorsal surface of the carpus and in connection with the extensor communis digitorum or the extensor carpi radialis longior. They probably arise from the small closed follicles demonstrated by Gosselin to exist in close connection with the synovial layer of the sheaths of the extensor tendons of the hand.

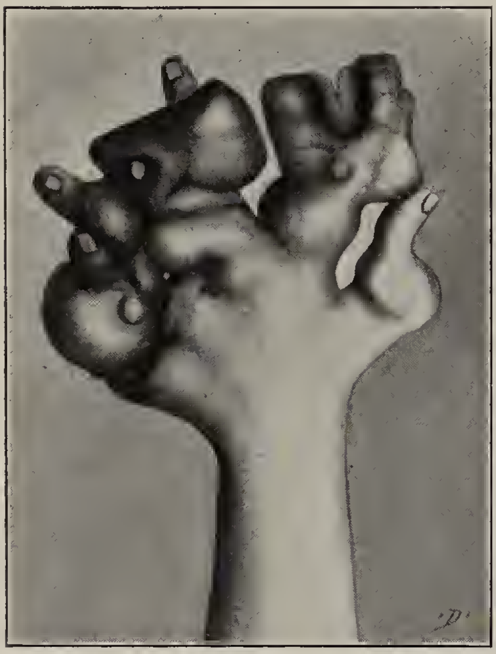

FIG. 742.—MULTIPLE ENCHONDROMA OF THE PHALANGES (AFTER LEO).

Compound ganglions occur almost exclusively in the large bursae mucosae of the common flexors on the palmar surface of the wrist, and contain bodies similar to rice or melon seeds, that give rise to a soft crackling on manipulation. The compound ganglion in this situation is a **chronic tuberculous bursitis** (König). The affection may extend for quite a distance up the forearm.

Treatment.—Simple ganglions may be punctured by a tenotome and the contents squeezed out. The skin should be drawn to one side and maintained in that position after the puncture by the tenotome itself until the contents are evacuated. The interior of the sac is then scarified before the tenotome is withdrawn (Hueter). Tincture of iodin may be injected with the blade of the tenotome as a guide. Recurrent and compound ganglions should be dissected out.

Witzel described ganglions connected with the synovia of the joints, particularly the metacarpophalangeal joints. They are met with more frequently in the feet than in the hands.

Chondroma and **osteochondroma** develop not infrequently in the bones of the hand and fingers. They are found more frequently in this situation than in any other portion of the body. They are usually found at the phalanges (Fig. 742), but occasionally on the metacarpal bones. Rarely they spring from the bones of the wrist, in which case they may attain a large size and require amputation (Fig. 743). They are very often multiple. They frequently begin in childhood, and probably originate in the remains of fetal cartilage.

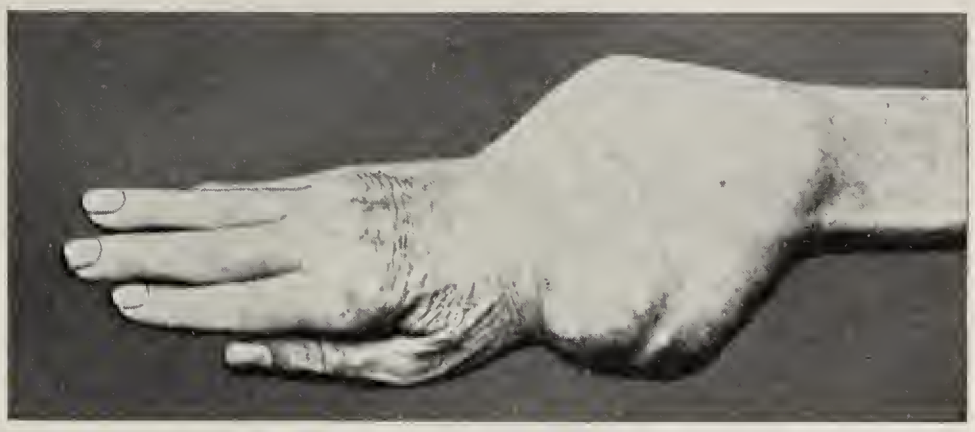
Fig. 743.—Enchondroma Springing from the Carpus.

Congenital Malformation of the Hand and Fingers.—Syndactylism or webbed fingers is a partial or complete fusion of the adjacent fingers, and rarely of all the fingers. The most common form is fusion of the middle and ring fingers; that of the thumb and index-finger is the least common. The connecting web usually consists of the soft parts alone; the bones are sometimes involved. This malformation is essentially an arrest of development.

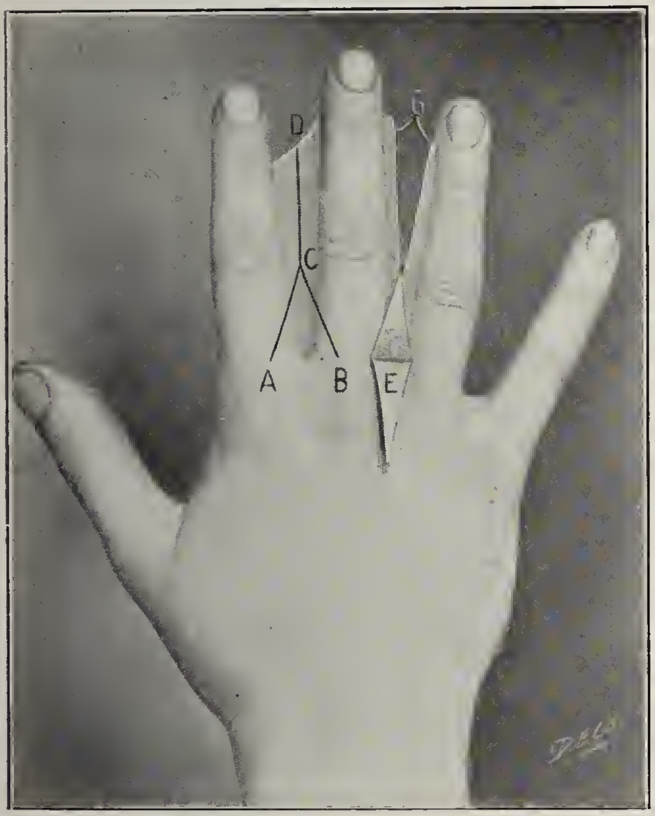

Fig. 744.—Zeller's Operation.
A, B, Incisions to form the flap; C, D, line of division of the web; E, flap to be placed in the cleft and sutured to the palmar surface.

The **treatment** is most successfully carried out by means of the operations designed to prevent reunion of the web after division. If this can be prevented from occurring at the site of the normal commissure, the raw surfaces for the remainder of the distance represented by the divided web can be prevented from reuniting by the simple interposition of gauze dressings. Zeller accomplishes this by dissecting a triangular-shaped flap, the base of which corresponds to the commissure to be covered, the apex being directed toward the finger-tips. The web is then divided and the flap sutured between the phalanges at the site of the normal commissure (Fig. 744). Didot covers the entire length of the raw surface by skin flaps, one taken from half of the dorsal surface of one of the fingers and the web and the other taken from half of the palmar surface of the other finger and the web. This splits the web in the direction of the plane and releases the fingers. The flap derived from the palmar surface of one finger is wrapped around the other finger and

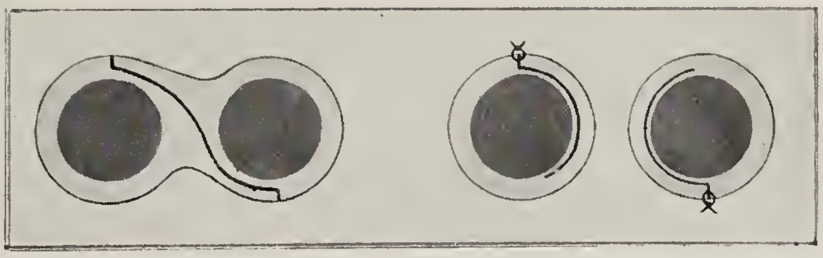
Fig. 745.—Diagram of Didot's Operation for Webbed Fingers. Sectional View.

vice versâ (Fig. 745). In cases in which other operations have failed and in which the presence of cicatricial tissue has prevented a repetition of the ordinary procedures, I have operated successfully by passing two triangular-shaped flaps through a "buttonhole" made at the site of the normal commissure

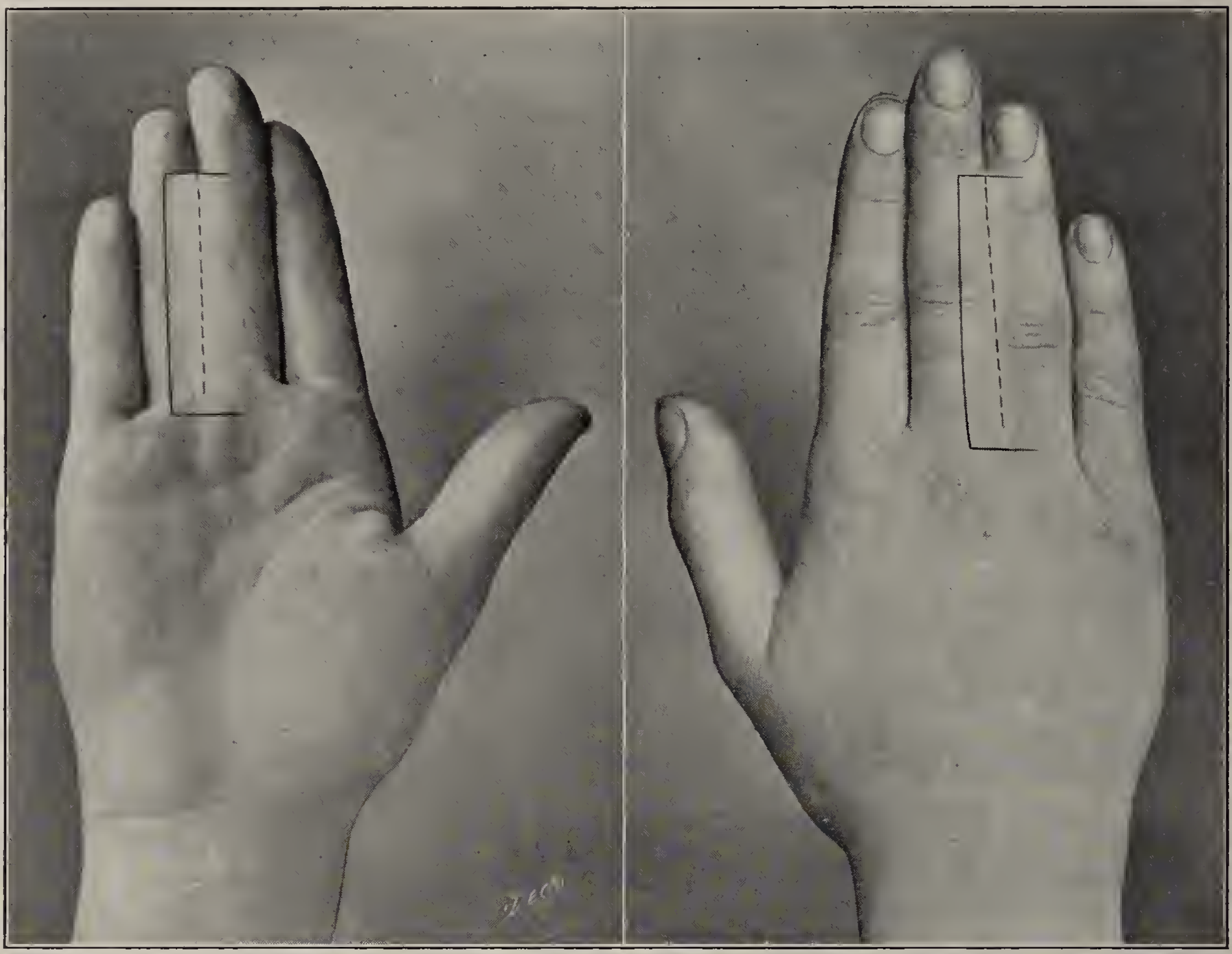

Fig. 746.—Didot's Operation for Webbed Fingers.

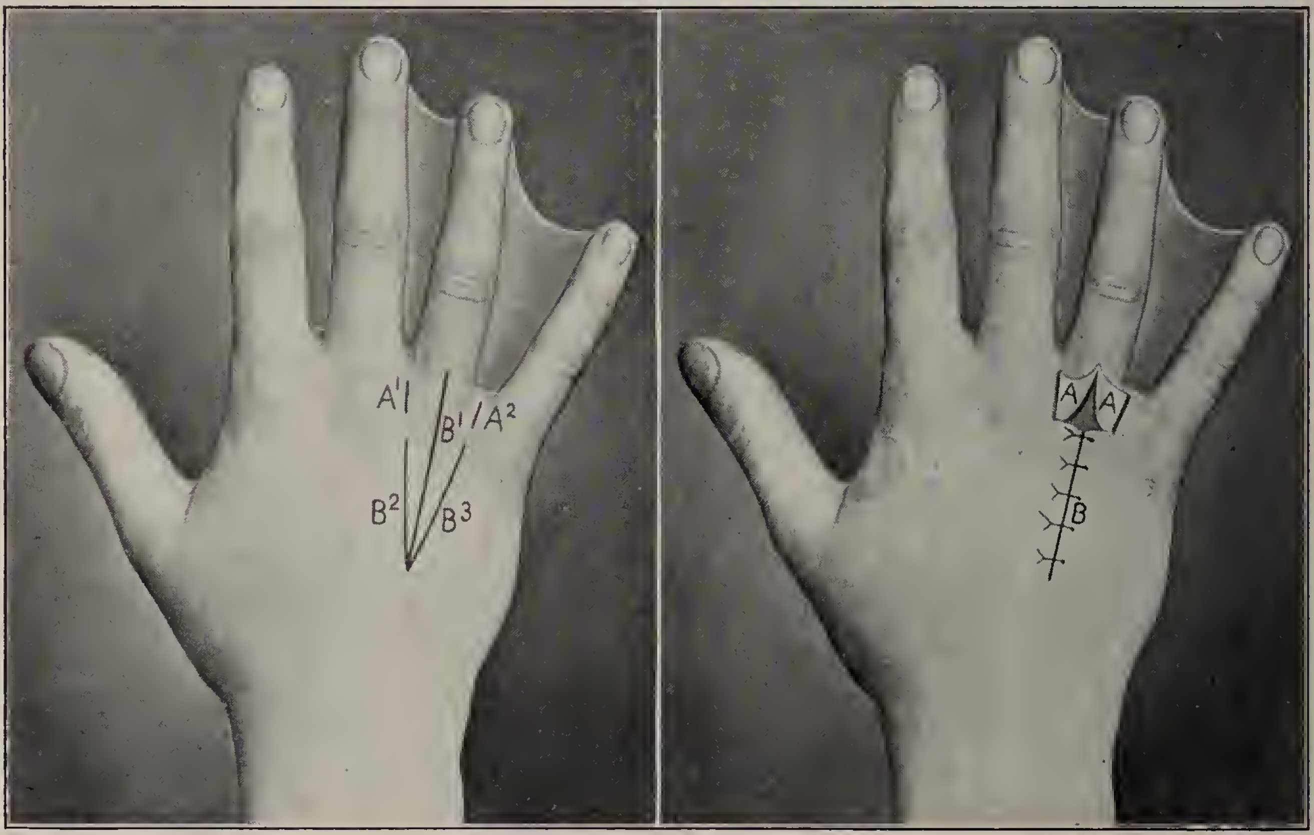

Fig. 747.—The Author's Operation for Webbed Fingers.

A^1, A^2, Site of "buttonhole" slits; B^1, B^2, B^3, lines of incision for the formation of the flaps.

A, A, The flaps passed through the slits; B, the gap from which the flaps were taken closed by a line of sutures.

by a narrow-bladed knife passed through at this point. This furnishes an integumentary lining to the "buttonhole." When these flaps have united, their pedicles or bases are separated and the web is divided its entire length (Fig. 747). During the after-treatment the raw surfaces are to be kept apart by interposed gauze dressings and the fingers supported by a straight splint.

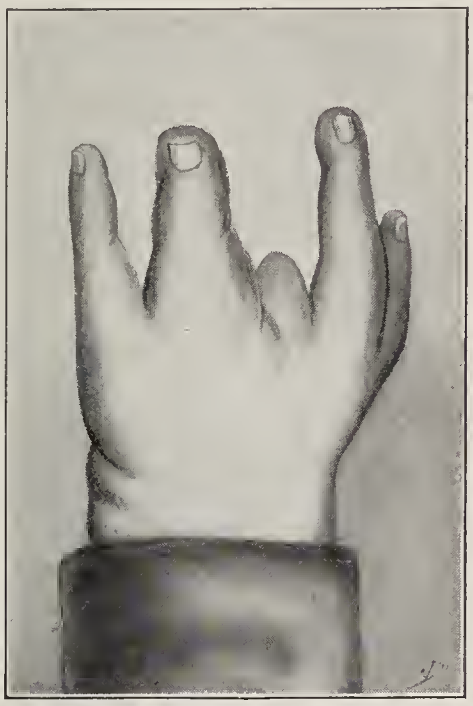

Fig. 748.—Brachydactylism.

Cleft hand is the opposite of syndactylism. The cleft sometimes extends to the carpus. It is a very rare affection and is almost always associated with some other malformation of the hand. The **treatment** consists in closing the cleft by a plastic operation.

Macrodactylism is a congenital hypertrophy of the fingers and occurs as a symmetric enlargement of the bones and the soft parts, such as lipomatous or cavernous growths. These cases, as a rule, do not require surgical treatment until they threaten to impair the function of the other fingers. They may remain stationary for years; lipomatous and cavernous tumors sometimes disappear spontaneously. The **operative treatment** consists in excision of the tumors when possible. Oftener, however, the entire finger will require **amputation.**

Brachydactylism is a congenital shortening of a finger, due to a lessening of the number of its phalanges (Fig. 748). Brachydactylism is generally associated with defects in the bones of the forearm. The opposite condition is elongation of a finger from superfluous phalanges. **Ectrodactylism** is an absence of entire fingers or sections of the hand.

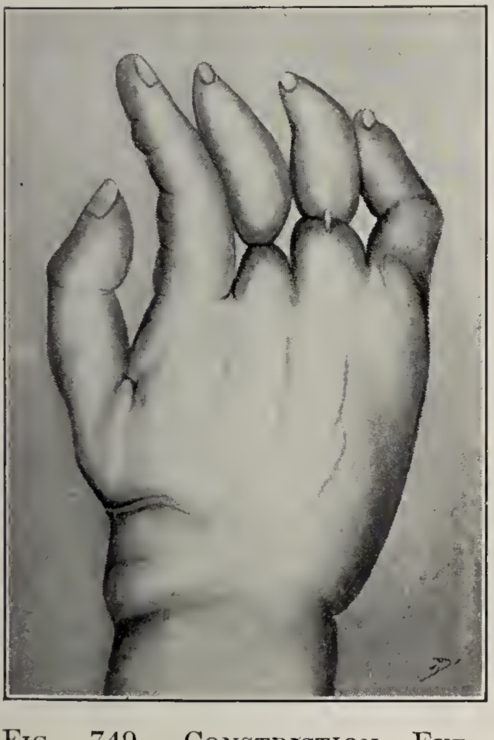

Fig. 749.—Constriction Furrows of Fingers.

Defects in the fingers and hand are sometimes dependent on **intrauterine constrictions** and **spontaneous amputations** produced by amniotic cords, adhesions with the amnion, or constriction by the umbilic cord (Fig. 749).

Polydactylism or supernumerary fingers is a common malformation occurring in the hand, and more rarely in the foot. Hereditary influences are probable. In Gruber's case there were 10 fingers on each hand and 10 toes on each foot. The anatomic condition consists of a "forked cleavage" of the phalanges, and occasionally of the metacarpal bones. It probably depends on a double germinal layer. Polydactylism usually takes the form of a supernumerary little finger or thumb. It is likely to be associated with other malformations. The malformation may take the form of a double fingernail, of fingerlike appendages, or of a fully developed supernumerary finger, including the metacarpal bone.

Congenital deviation of the phalanges toward either the palmar, the dorsal, or the lateral aspects of the hand is sometimes observed.

Operative procedures in these cases of congenital malformations of the hand and fingers must be planned in accordance with the requirements of each case.

Resection of the Wrist-joint.—The **indications** for resection of the wrist-joint are (1) chronic disease of the carpal bones alone, or of the metacarpocarpal or the radiocarpal articulation; (2) certain cases of injury, as, for instance, gunshot wounds and compound fractures; (3) irreducible dislocations and ankylosis.

In extensive tuberculous disease of the wrist with involvement of the soft parts, particularly of the tendinous sheaths, amputation should replace resection.

Resection of the wrist should be preceded by the application of the Esmarch bandage, the latter always being commenced above the diseased part. The operation is a complicated one, owing to the necessity of preserving the arteries, nerves, tendons, and when possible, the tendon-sheaths, as well as the periosteum.

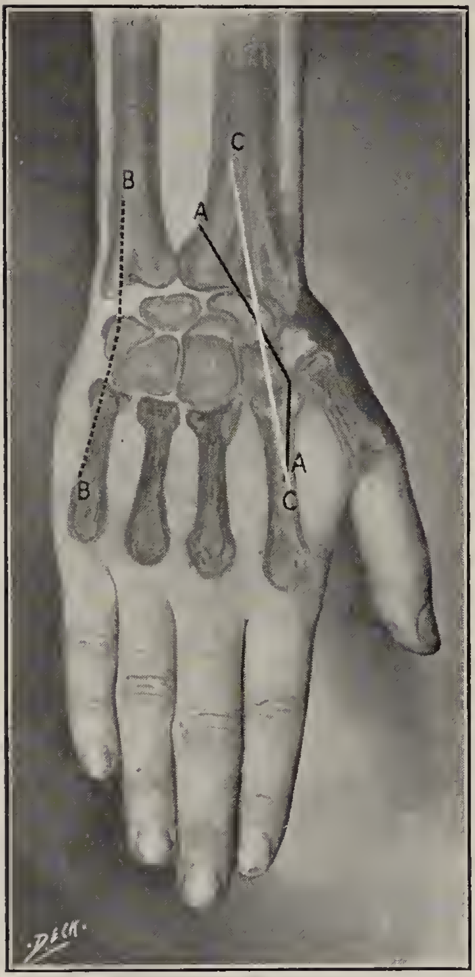

Fig. 750.—Resection of the Wrist.

A, A, Lister's posterior incision; B, B, Lister's anterior incision; C, C, the Langenbeck-Boeckel line of incision.

Partial Resection.—This may consist of extirpation of the bones of the carpus, the articular extremities of the radius and ulna as well as those of the metacarpal bones being preserved, if found to be healthy. While the pisiform bone may frequently be preserved, attempts to isolate and remove individual bones in advanced tuberculous disease of the wrist-joint have usually been followed by relapse.

Complete Resection (Lister's Method).—The radial incision commences at the outer margin of the dorsal aspect of the radius, slightly above the level of the styloid process, and is carried in a straight line to the radial side of the metacarpophalangeal articulation of the index-finger, running somewhat parallel to the extensor longus pollicis; thence it is carried downward as far as the middle of the second metacarpal bone (Fig. 750). The extensor carpi radialis longior and the extensor carpi radialis brevior are divided at their insertions, the extensor longus pollicis, together with the radial artery, being retracted toward the thumb.

The trapezium is now loosened from the remainder of the carpus but allowed to remain *in situ* until after the removal of the latter. The hand is bent strongly backward to relax the extensors and the soft parts dissected up as far as possible on the ulnar side of the dorsum.

The ulnar incision commences two inches above the end of the bone, is carried down between the bone and the flexor carpi ulnaris, and terminates at the middle of the fifth metacarpal on its palmar aspect. The dorsal edge of the incision is retracted and the extensor carpi ulnaris cut at its insertion. The extensor tendons of the fingers are separated from the carpus but not from the radius; the dorsal and internal lateral ligaments of the wrist-joint are divided. The anterior surface of the ulna is cleared, the knife following closely the bone in order to avoid the artery and nerve, the articulation of the pisiform bone is opened, and with the hand strongly flexed to relax the flexor tendons these are separated from the carpus. If the unciform process is in the way, it should be divided at its base by cutting forceps. In clearing the soft parts anteriorly care should be taken not to carry the knife farther down the hand than the heads of the metacarpal bones, lest the deep palmar arch be wounded. The anterior ligament of the wrist-joint is now divided, the connection between the carpus and the metacarpus is separated, and the bones of the carpus, either together or singly, removed through the ulnar incision. Ordinarily, particularly in extensive disease of these, the ligamentous structures are thickened and the bone softened, so that the latter gives way under the grasp of the sequestrum forceps and it becomes necessary to employ an elevator to lift out the individual bones of the carpus, the knife or scissors being employed here and there to sever any ligamentous connections.

The articular ends of the bones of the forearm now remain to be dealt with. Strong eversion of the hand will bring into prominence the ulna at the anterior incision, and sometimes the radius may be protruded through the same opening. If not, strong retraction of the margins of the radial incision will sufficiently expose its articular extremity. The amount of bone removed will be governed by the extent of the disease. In any event, the radius and ulna are left the same length. The saw-cut, in the case of the ulna, runs obliquely so as to include the part over which the radius sweeps and at the same time spare the base of the styloid. In the case of the radius, it runs parallel to the articular surface.

In removing the heads of the metacarpal bones it will be found that the second and third are most readily reached from the radial, and the fourth and fifth from the ulnar incision.

The trapezium, the removal of which is postponed until the rest of the carpus has been removed, is now dissected out without difficulty. Care is to be observed to spare the tendon of the flexor carpi radialis, with which the bone is in intimate relationship on its palmar aspect; the radial artery is also to be avoided at this point by keeping the knife close to the bone. The thumb is now forced up by an assistant to facilitate the removal of the articular extremity of its metacarpal bone. If the pisiform bone is not diseased, it should be allowed to remain, as this gives insertion to the flexor carpi ulnaris and serves for the attachment of the annular ligament.

Resection by Means of a Single Longitudinal Dorsal Incision (Langenbeck, Boeckel).—This method may be employed with advantage in children and in young adults, particularly females, in whom the ligamentous and other fibrous structures retract readily. The hand is flexed laterally toward the ulnar side and a straight dorsal incision made on the radial side in the interval between the extensor indicis and the extensor secundi internodii pollicis (Fig. 750). This incision extends from a point about an inch and a quarter above the wrist to the middle of the second metacarpal bone and runs closely along the radial border of the tendon of the extensor indicis. The extensor tendons of the carpus on the radial side (extensor carpi radialis longior and extensor carpi radialis brevior) are separated from their attachments, after the capsule of the wrist-joint is split in the direction of the skin incision. The periosteum, together with the capsule of the joint and the overlying structures, is loosened from the second and third metacarpal bones by means of the raspatory. With the hand forcibly flexed and the soft parts retracted, the intercarpal ligaments connecting the scaphoid, semilunar, and cuneiform bones are divided with the point of the resection knife, a narrow elevator introduced between these, and the bones of the upper carpal row pried out one after the other. The pisiform bone, if healthy, is permitted to remain.

The lower row of carpal bones is now to be removed. The interarticular ligaments between the trapezium and the trapezoid are divided with the knife, the connections between the trapezium and the metacarpal bone of the thumb separated, and, by means of the elevator, directed from the radial toward the ulnar margin, the trapezium, which has separate connection with the metacarpal bone of the thumb, is pried from its position; after this the remaining three bones of the second row, namely, the trapezoid, the os magnum, and the unciform, are loosened from their connections with the metacarpal bones and removed either together or singly.

The articular extremities of the bones of the forearm are now to be dealt with. The lateral ligaments are to be separated subperiosteally, care being taken on the radial side not to injure the radial artery. By the aid of strong palmar flexion the ends of the radius and ulna are forced out of the wound in the soft parts and the joint surfaces sawed across, the triangular cartilage and capitellum of the ulna being removed. The end of the radius may be removed by means of the chisel or Gigli saw. Should the metacarpal bones be diseased, the dorsal incision may be lengthened and these removed with the cutting forceps.

In all cases of resection of the wrist-joint for disease a free application of the curet should be made to all suspicious points in the soft parts.

The extensive cavity left by the removal of bone should be loosely packed with iodoform gauze and copious dressings of sterile gauze applied.

In the **after-treatment** the forearm must be kept in semipronation. Ordinary anterior and posterior splints may be employed, these extending from the elbow to beyond the finger-tips. The most scrupulous cleanliness must be observed. Passive movements of the fingers should be commenced on the second day and continued daily. The flexion and extension movements must be complete, for on these depend the patient's chances for regaining a useful hand. In making these movements the metacarpal bone of each finger must be held firmly in turn in order to avoid disturbing the wrist. Later on, as the healing process advances, the splints should be shortened so as to allow free play to the fingers, and the patient encouraged to move these as much as possible.

Resection of the Metacarpal Bones and Joints of the Fingers.—Amputation is never required for even the most severe injuries of the **metacarpal bones.** The worst cases of tuberculous osteomyelitis and of chondroma in this region require, at the most, total resection through a longitudinal incision on the dorsal surface. The periosteum and tendons are carefully drawn aside and the bone loosened from its connections at each end and removed. If possible, the epiphysis is spared at each end, to avoid opening into the adjacent joints.

Resection of the finger-joints is indicated in recent injuries of the joints which become infected, in order to afford efficient drainage and protection of the sheaths of the tendons from infection; in cases of chronic suppuration this is indicated for the same purpose, as well as for the purpose of shortening the duration of the suppuration. Resection may also be performed to improve the function after healing has taken place, provided the tendons are in a condition to produce active movements in the joints.

The tendons and their sheaths must be carefully protected against injury in cases of resection of the joints of the fingers. A longitudinal incision is made between either the radial or the ulnar edge of the extensor tendon and the lateral edge of the finger, the tendinous sheath, and the digital nerve and artery of the corresponding side being thus avoided. The incision opens the joint laterally. Separation of the capsular attachments is effected on the dorsal and palmar aspects of the bone, and the articular extremity is forced out of the wound and divided, preferably with a fine saw. The concave articular surface is to be saved if possible. The finger is fastened to the next finger and pasteboard splints applied. The metacarpophalangeal joint of the thumb is accessible only after separation of the muscles of the thenar eminence.

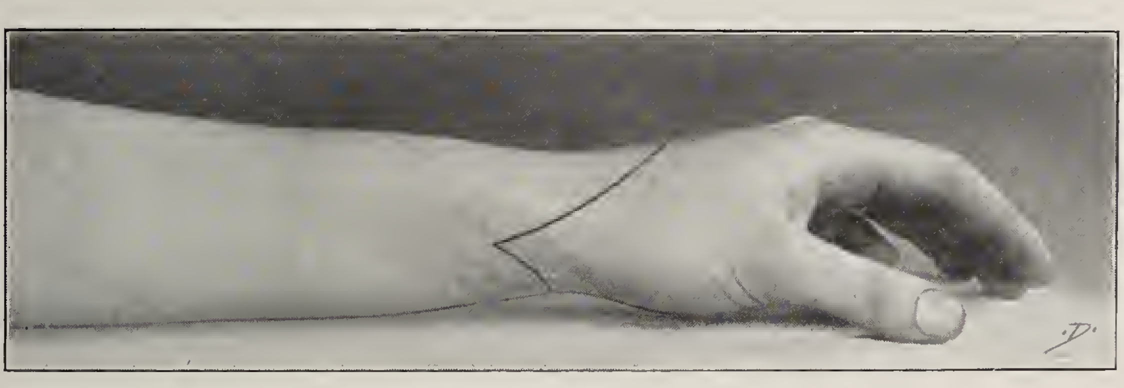

Fig. 751.—Amputation of Hand.
Dorsal and palmar flaps.

The **resection of entire phalanges** may be indicated by extensive tuberculous osteomyelitis, by enchondroma, etc. The resection is effected through lateral incisions. Good functional results cannot be expected and in many cases amputation is to be preferred. **Phalangeal sequestra** following felon, particularly at the ungual phalanx, are usually easily removed through already existing openings, these being enlarged if necessary. **Sequestrotomy** of the metacarpal bones sometimes requires enlargement of cloaca and chiseling away of portions of the involucrum.

Amputation of the Hand.—The **indications** for amputation of the hand are as follows: severe crush injuries, extensive and persistent caries of the wrist-joint, and numerous and large enchondromas of the fingers and metacarpal region.

The operation aims to avoid the presence of the structures of the palm in the flap. The hand is removed at the radiocarpal joint, the line of which corresponds to a transverse dorsal line uniting the two styloid processes while the hand is in palmar flexion. A short palmar and a long dorsal flap may be marked out as in Fig. 751 or the exigencies of the case may require a skin flap taken from the thenar eminence (Fig. 752).

Amputation by Means of a Dorsal and Palmar Flap.—The apices of the styloid processes are the guides for the two extremities of the base of the flaps. The dorsal skin flap extends to the middle of the dorsal surface of the hand (Fig. 751). It is dissected up to the line of the joint, which is opened by a transverse incision on its dorsal aspect. The ligaments on the lateral and palmar aspects are then divided. Traction is made on the hand in slight flexion, in order to make tension on the flexor tendons; these are now divided transversely and the short palmar incision made from within the wound.

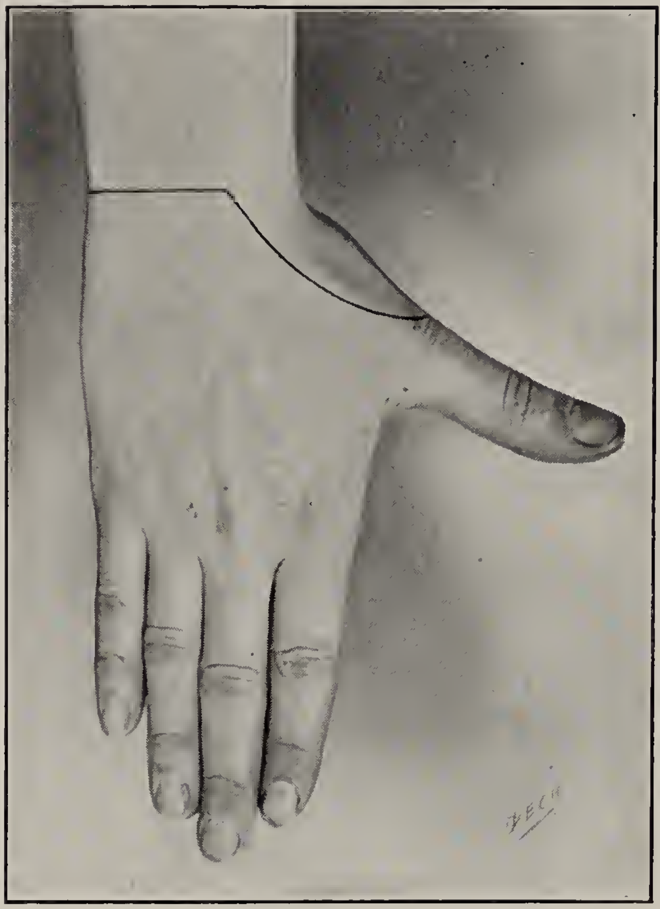

Fig. 752.—Amputation of Hand. Skin flap.

Atypic amputation of the middle of the hand is more frequently called for than a formal removal of a portion of the member at the metacarpus. The surgeon aims to preserve, as far as possible, the soft parts that have escaped serious injury, fashions the flaps accordingly, and then removes the osseous structures to accommodate these.

Amputation of the Forearm.—In this amputation a circular incision, with skin flaps, is sometimes employed. The method with anteroposterior flaps, the latter including the skin and muscular structures, is to be preferred for the upper third in moderately muscular subjects. Even here, with large masses of muscular tissue, it may be necessary to divide the muscular layer circularly in order to avoid the bulging of these during coaptation. With the arm abducted from the trunk the flaps are made by transfixion and cutting from within outward. The flaps are retracted and the muscular structures between the bones, together with the

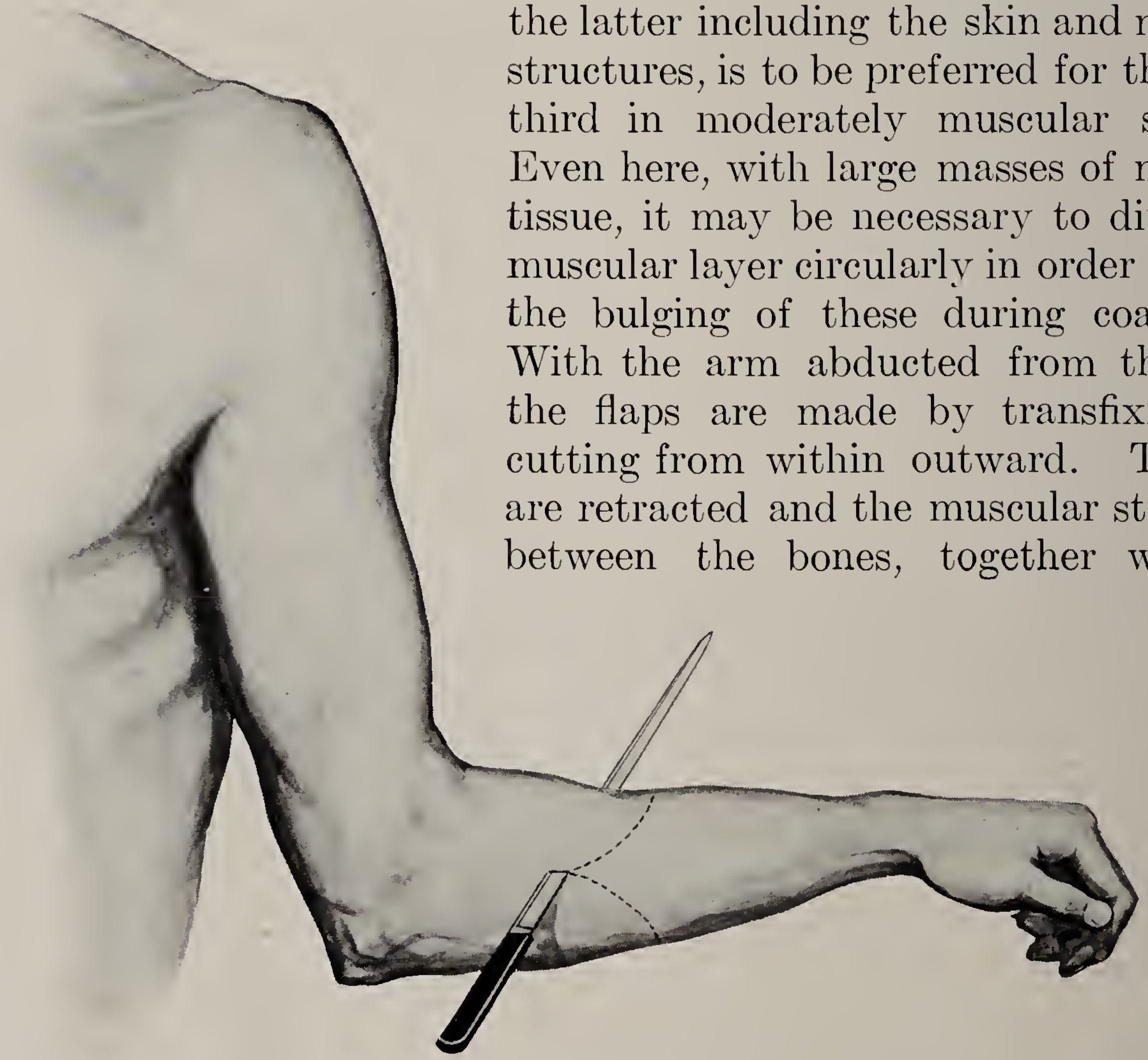

Fig. 753.—Amputation of Forearm by Transfixion and Anteroposterior Flaps.

interosseous ligament, severed with a narrow catlin passed between the radius and the ulna and swept first around one bone and then the other. The soft parts are retracted with a three-tailed retractor. Both bones are divided simultaneously from the palmar aspect, with the arm held in a position of complete supination. In order to retain the power of supination and pronation the insertion of the pronator radii teres should be spared as much as possible. The radial and ulnar, and the two interosseous arteries are tied, together with various muscular branches. The nerves are to be drawn out and severed on a somewhat higher level (Fig. 754).

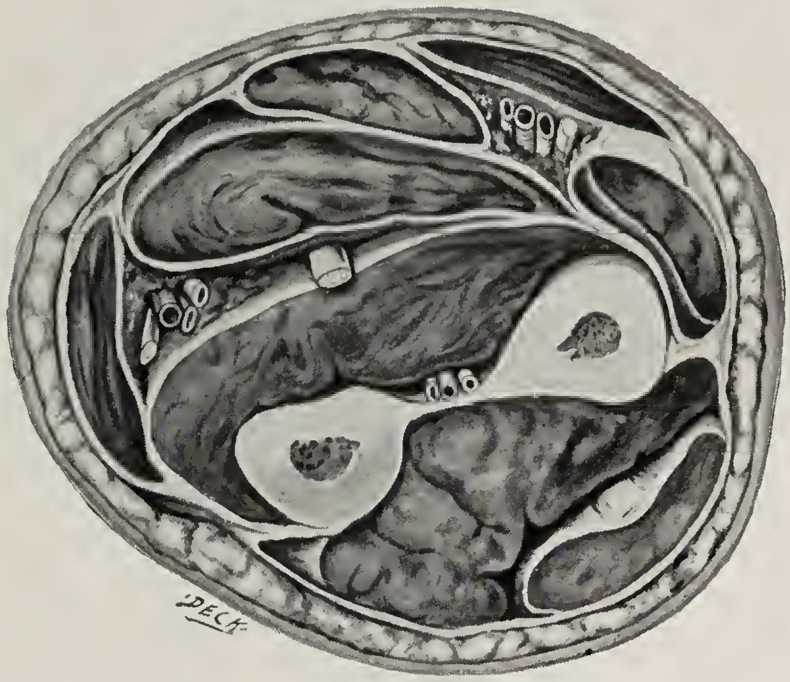

Fig. 754.—Transverse Section of Middle Third of Left Forearm.

The formation of the flaps by transfixion is not suited to the lower third of the forearm, owing to the presence of the numerous tendons. Here a short anterior and a long posterior flap are fashioned. These should always include the fascia, in order to preserve the vessels which supply the skin.

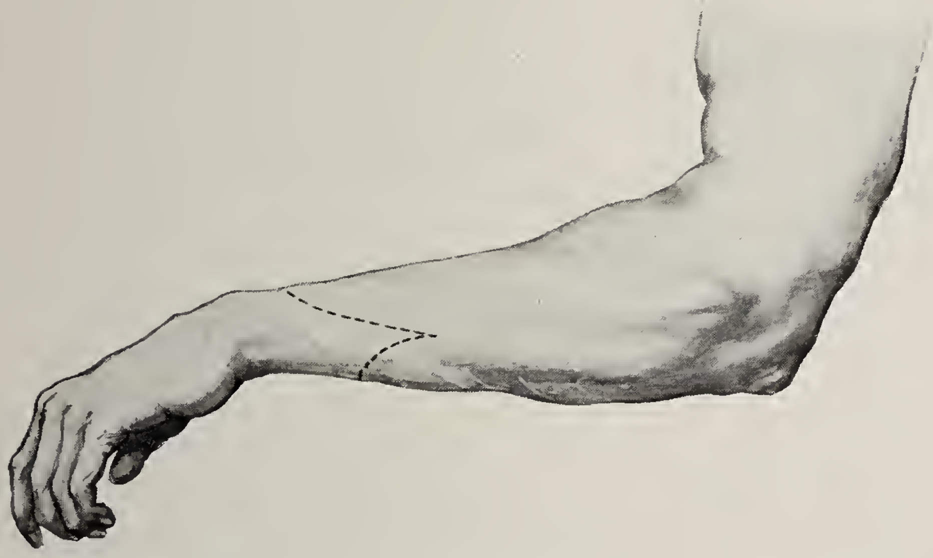

Fig. 755.—Amputation of Forearm (Lower Third) by Method of Skin Flaps.

Amputation of the Fingers.—Amputation of the fingers is required in severe injuries, simultaneous suppuration of the joints and sheaths of the tendons, extensive tuberculous osteomyelitis of the bones of the phalanges, certain contractures, and finally enchondroma. The operation is simple; the one guiding principle to be borne in mind is that **the cicatrix must lie on the dorsal surface.** A palmar cicatrix is devoid of the tactile sense. Fig. 756 shows the lines of incision in amputation through a joint (**amputation in contiguity**). The joint is opened transversely.

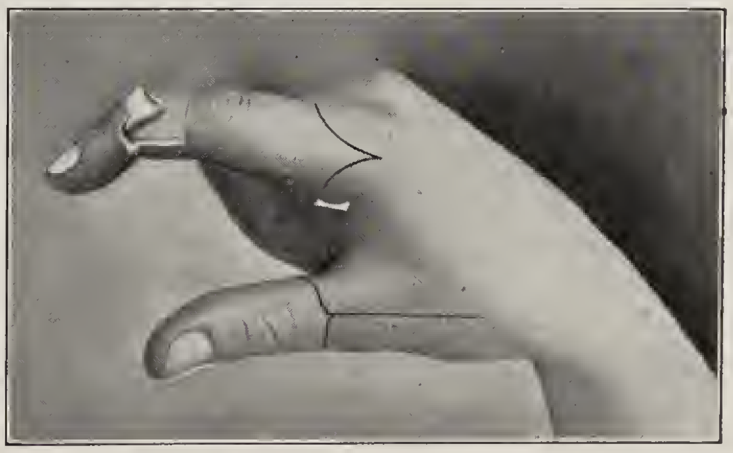

Fig. 756.—Amputation of Finger and Thumb.

Amputation in continuity may be performed where it is desirable to preserve a larger stump. This should be done in the case of the thumb, whenever possible, in order to preserve the function of the latter to the utmost.

In the case of removal of the entire middle or ring finger it may be desirable in other than working-men to perform a **cosmetic operation.** An incision is made from just below the carpometacarpal joint to the knuckle, with the finger partly flexed. From this point two curved incisions are made; these are joined by a transverse incision in front (Fig. 757). The metacarpal bone may be cut across with a cutting forceps close to its upper extremity or disarticulated at the carpometacarpal joint. Commencing above, the operator then frees it from the soft parts, and removes the finger and metacarpal bone together. The dorsal wound is sutured and drainage effected through a small opening left at the palmar surface. The method of amputation of a finger with all or a portion of a metacarpal bone may be applied to either of the other fingers. In the case of the little finger the longitudinal incision may be made more to the ulnar side, and of the index-finger to the radial side.

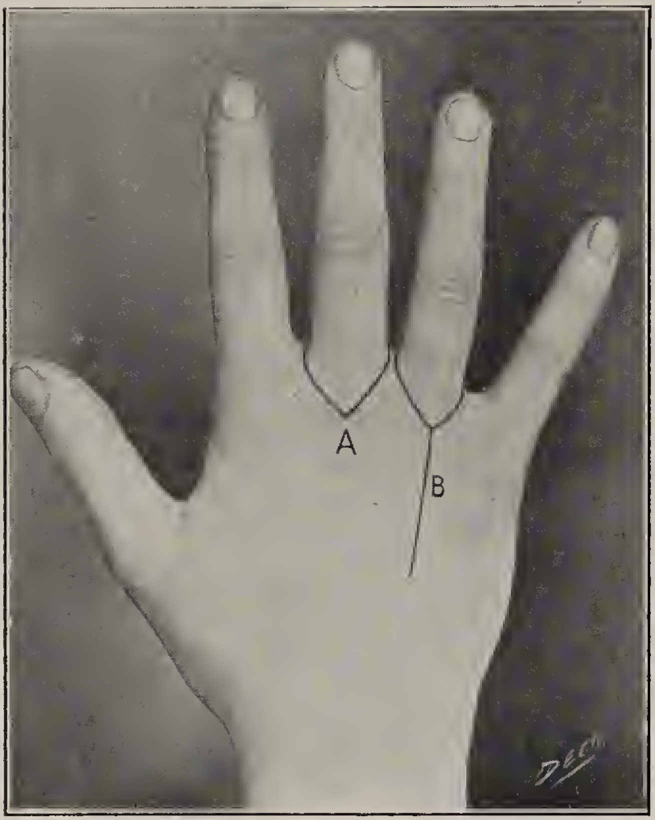

FIG. 757.
A, Amputation of finger at the metacarpophalangeal articulation; B, amputation of finger with part of the metacarpal bone.

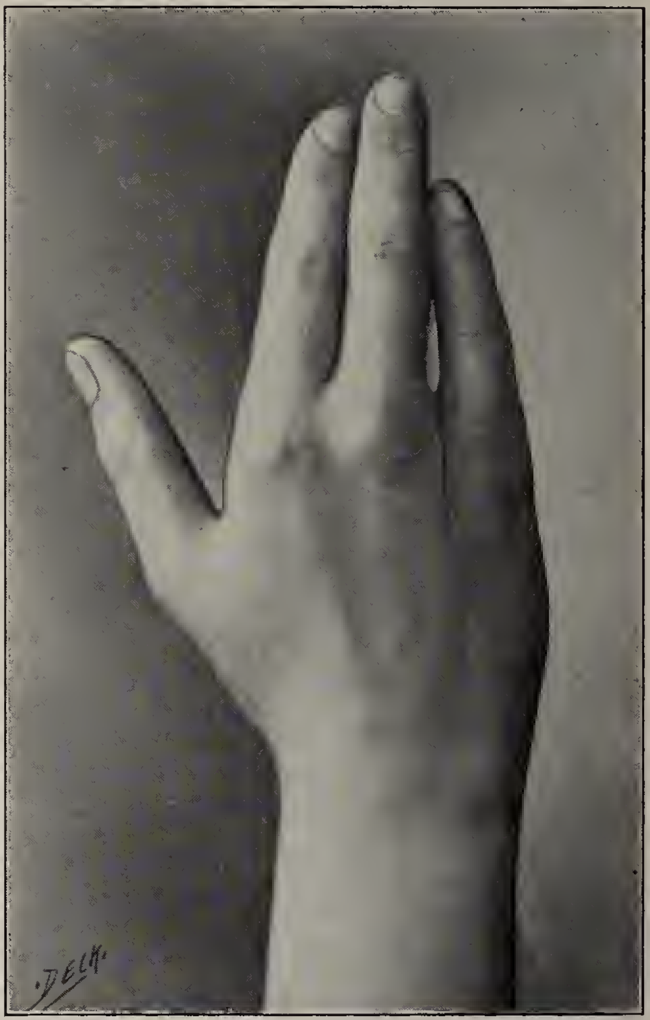

FIG. 758.—AMPUTATION OF FINGER WITH PART OF THE METACARPAL BONE.
Appearance after healing.

Isolated amputation at the metacarpophalangeal articulations is made as follows: The hand is held in pronation and an oblique incision is made over the head of the metacarpal bone. The lower end of this is carried obliquely across the interdigital web to the crease on the palmar surface, which it follows across, and thence passes obliquely upward on the other side to join the original cut. The tissues are divided to the bone. Finally, the ligaments are divided, the parts cleared, and the tendons drawn out and divided. In amputations of all the fingers a transverse dorsal incision is made, the metacarpophalangeal joints opened, the ligaments divided, and a palmar flap subsequently fashioned.

SECTION XXI

THE SURGERY OF THE LOWER EXTREMITY

THE HIP-JOINT

The hip-joint is protected by large masses of muscular tissue and hence injuries from direct traumatism are rare, the latter being practically limited to contusions of the capsule and to gunshot injuries. In preaseptic days gunshot injuries were almost invariably followed by fatal septic inflammation.

Dislocations and fractures in this region are far more frequent than injuries from direct traumatism. This arises from the support given by the lower extremity to the weight of the trunk in standing and walking, as well as from the long leverage afforded by the limb in transferring slight forces with great power to the hip-joint and the neck of the femur. Other causative factors are variously efficient at different periods of life, these relating chiefly to the physical characteristics of the osseous and ligamentous structures. In childhood the ligaments of the hip-joint are too elastic to tear easily and the shaft of the bone too soft to resist the force which otherwise would produce a dislocation. Hence dislocation is rare and fracture of the shaft in the middle third relatively common. After the twentieth year the ligaments lose their elasticity and the bone becomes greatly increased in resisting qualities; hence the ligaments give way and the bone remains intact, dislocation occurring more readily than fracture under these circumstances. Finally, in advanced years the arch-shaped cancelli of the neck of the femur undergo atrophy, the bone becomes more brittle, and fracture of this part of the bone is of more frequent occurrence than fracture of the shaft of the femur or dislocation of the hip-joint.

TRAUMATIC DISLOCATION OF THE HIP-JOINT

The normal movements of the hip-joint consist of flexion and extension in the anteroposterior direction, lateral abduction and adduction, and inward and outward rotation around the vertical axis. These movements are limited by the resistance of the muscular structures and by that of the capsular ligament, since greater range of motion exists in the cadaver than in the living body.

In the mechanism of a dislocation this muscular resistance is first overcome; after this, the dislocating force continuing, the articular surfaces are separated from each other and the head of the bone approaches the edge of the acetabulum and impinges against the capsule. The weakest point in the latter is its lower portion or the point of attachment of the ischiofemoral ligament, so that the femoral head is forced through the capsule more easily here than at any other point. The head of the femur can be driven against this portion of the capsule only in movements of extreme flexion; hence the most frequent form of dislocation is that known as **flexion dislocation.** This is usually combined with an inward movement of the limb (simultaneous flexion and adduction), from the fact that there is less muscular resistance to be overcome in this than in the opposite direction, that of abduction. In addition, the normal deviation of the limb is in the former direction and forces producing dislocation are more frequently applied from the outer aspect of the limb. In dislocation resulting from the falling of heavy masses on the whole body, the trunk is forced against the heads of both femurs and is flexed and partly rotated. Here **double dislocation** may occur, a flexion adduction dislocation resulting on one side and a flexion abduction dislocation on the other.

As the head of the femur leaves the acetabulum and is forced through the capsule it loses its point of support, as far as its articular surfaces are concerned, this being transferred to the points of attachment of the strong iliofemoral ligament (the inverted Y-ligament of Bigelow) by two fasciculi, one at each end of the anterior intertrochanteric line. Supported by this strong ligamentous structure the upper portion of the shaft of the bone is held from further backward displacement, while the head, after reaching the posterior part of the joint, is left practically free to find a final resting-place at whatever point it may have reached when the dislocating force ceased to be exerted. Hence the head may be arrested low down, when a sciatic dislocation takes place, or higher up, as in the case of a dislocation on the dorsum ilii.

Classification.—The following is the classification of Stimson, slightly modified:

Backward and upward	Sciatic and iliac. Everted dorsal.
Downward and inward	Obturator. Perineal.
Forward and inward (Suprapubic)	Iliopectineal. Pubic. Intrapelvic.
Dislocation directly upward	Supracotyloid or subspinous.
Dislocation downward on the tuberosity of the ischium.	

The names of the principal groups indicate the direction of the displacement and the position of the tear in the capsule; the names of the varieties indicate either the place where the head of the bone finally rests or a special symptom of the variety.

Sciatic and Iliac Dislocations.—In **sciatic dislocation** the head of the femur is forced against the lower and outer edge of the acetabulum at the level of the sciatic notch, while the extremity itself moves in the direction of extension. This, however, can take place only to a limited extent, as far as the unruptured portions of the capsule permit, the femur remaining in a position of slight flexion. The position of an adduction present at the commencement of the dislocation persists and is further assisted by the tension on the intact ligaments, particularly the pubofemoral portion of the capsular ligament and the iliofemoral or inverted Y-ligament of Bigelow. The tension on these latter tends to dislocate the head of the femur still further inward. The position of the femur, therefore, in sciatic dislocation is that of moderate flexion adduction, and inward rotation.

In case, however, the secondary extending effort is of sufficient force to rupture the posterior portion of the capsule, the head of the femur passes above the sciatic notch and finally finds a resting-place on the posterior and inner portion of the dorsal surface of the ilium, a dislocation on the dorsum ilii resulting. The dividing-line between a sciatic and an iliac dislocation, according to Bigelow, is represented by the obturator internus muscle. The position of the femur is nearly the same in both dislocations, these two dislocations differing only in degree; the flexion is somewhat less, owing to the more powerful effort at extension, and the adduction and inward rotation are greater, owing to the increased tension of the capsule and the fact that the dislocated head touches the flattened ilium only at one point in the iliac dislocation. The femur rotates inward until the anterior portion of the trochanter is arrested by the ilium. The gluteal fold is obliterated by the effusion of blood and the presence of the head of the femur, and the inguinal fold is somewhat deepened.

Diagnosis.—The dislocation of the femur upward is best demonstrated by **Nélaton's test line.** Under normal conditions the upper border of the trochanter major lies in a line drawn from the point of the anterior superior spinous process of the ilium to the tuberosity of the ischium. In sciatic dislocation the point of the trochanter major lies from three-fourths of an inch to an inch and a half above this line; in iliac dislocation, from one inch and a half to three inches. The appearance of the limb in either of these dislocations suggests a greater shortening than these figures indicate, but the real shortening is accompanied by an apparent shortening due to the flexion of the hip and knee and an adducted position of the thigh. Both the real and the apparent shortening are greater in iliac than in sciatic dislocation.

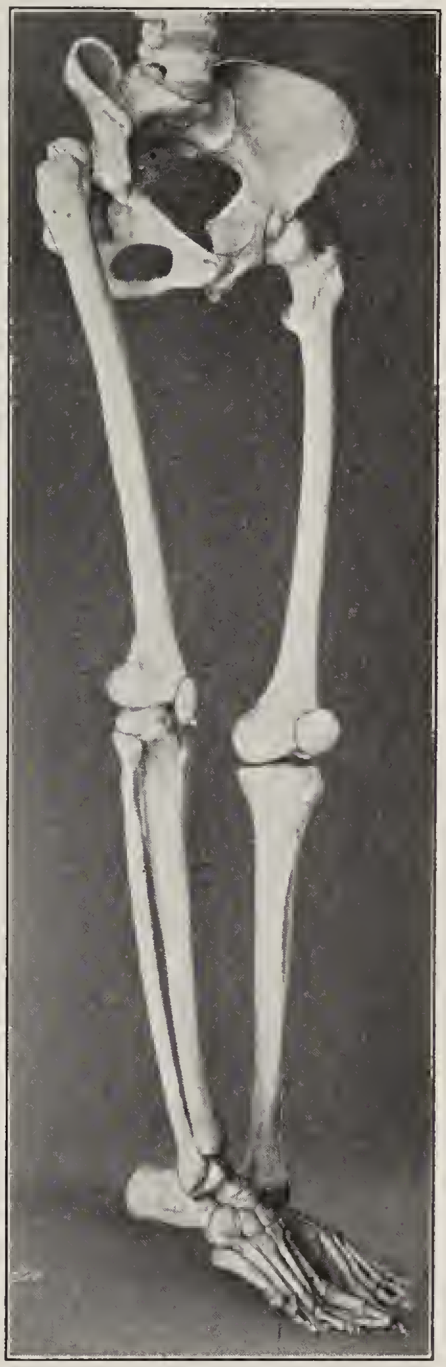

Fig. 759. — Dislocation on the Dorsum Ilii.

Examination immediately after the accident and before the effusion of blood, as well as some weeks later, when this has subsided, will reveal the head of the bone in its new situation beneath the gluteal muscles, so that the differentiation between a sciatic and an iliac dislocation is easily made. In the intervening period, owing to the presence of the before mentioned effusion, it is often impossible to distinguish between the two. This, however, is not important, since it suffices, as far as the treatment is concerned, to demonstrate clearly that either one of these varieties exists. It is not difficult to do this and there can be no possible excuse for failure to recognize to this extent the condition present. Considerable shortening after an injury can be due only to either fracture of the neck of the femur or sciatic or iliac dislocation, if we except those extremely rare cases of fracture of the pelvis in which the fragment with the acetabulum is carried inward. Considerations of age will assist here: fracture of the neck of the femur is relatively frequent in old persons and very rare in the middle-aged and in young persons. Unless prevented by impaction the lower fragment is displaced upward in a manner quite similar to the upward dislocation, but this shortening is almost invariably accompanied by an outward rotation or eversion. The two clinical pictures presented are entirely different. Disregarding the shortening, in the one we have outward rotation and absence of adduction (fracture), while in the other we have inward rotation, flexion and adduction (dislocation). In doubtful cases examination under ether will decide the diagnosis. In nonimpacted fracture of the neck of the femur all the normal movements of the hip-joint can be performed at the seat of the fracture; in impacted fracture they can be performed at the hip-joint. In case a dislocation is present, abduction and complete extension are impossible. In dislocation there is no crepitus; in nonimpacted fracture this is present. In fracture simple extension removes the displacement, which immediately recurs when the limb is released; in dislocation, the dislocation disappears only on reduction, and there is no recurrence. Such complications as simultaneous fracture of the neck of the femur may confuse the diagnosis, but these are exceedingly rare.

Everted Dorsal Dislocations.—It sometimes happens, though very rarely, that the inward rotation is replaced by an **outward rotation.** This is due, as a rule, to rupture of the outer branch of the inverted Y-ligament (Bigelow).

Reduction of Sciatic and Iliac Dislocations.—Reduction is to be accomplished by the anatomicophysiologic method, namely, by the reversal of the movements which produced the dislocation, aided by traction with the thigh in the position of flexion. Pulleys and such apparatus are no longer required. Since the introduction of the anatomic method the movements to be described later on are sufficient to accomplish the reduction even after the lapse of weeks and, in rarer instances, of a year.

The mechanism of the production of the dislocation and its reduction should be studied on the cadaver of a middle-aged man, as follows: In the absence of the powerful lever devised by Oscar H. Allis, in his extensive and valuable researches in this department of surgery, for the purpose of imitating the force applied by a fall from a height, and in order to make it possible to produce the dislocation, the capsular ligament must be weakened by making a subcutaneous section of the capsule at the lower and external edge of the acetabulum. In order to accomplish this with ease and celerity, the thigh should be flexed and adducted, when the head of the bone becomes prominent and serves as a guide for the incision. By forcible flexion and adduction the capsule ruptures still further and the head leaves the acetabulum. As this takes place the limb is allowed to drop; its weight in falling imitates the secondary movement of extension caused in the living subject by the tension on the elastic intact portions of the capsule, the iliofemoral or inverted Y-ligament, and a sciatic dislocation is produced. This dislocation is classified by some writers as a pure backward dislocation, but inasmuch as some shortening is produced by it, and as, in addition, the marked upward iliac dislocation is only an exaggeration of the same condition, it is thought best, for the sake of clearness in the description, to call it an upward dislocation. The **anatomicophysiologic method of reduction** consists in relaxing the anterior portion of the capsule, or the Y-ligament, and by making traction and swing-ing the femur on this as a pivotal point, restoring the head of the bone by causing it to follow the route in a direction reverse to that which it traversed in its escape from the acetabulum. To accomplish this, the following movements are to be executed in the order given:

1. **Inward Rotation and Adduction.**—In this step the capsule is relaxed and the head lifted from the posterior surface of the pelvis. The leg is flexed to a right angle with the thigh, the right hand grasping the ankle, the left resting on the knee.

2. **Flexion of the Thigh to a Right Angle.**—This is done gently and preserves the existing adduction and inward rotation.

3. **Traction.**—This renders the capsule tense and permits its utilization in the next step in the manipulation. In this step of the procedure both hands are placed in the popliteal space and a lifting movement made. In the case of a muscular adult it may be necessary to supplement this by passing a bandage tied in a loop under the patient's flexed knee and over the surgeon's shoulders (Stimson).

4. **Outward Rotation.**—This makes tense the outer band of the iliofemoral or inverted Y-ligament, as well as the posterior part of the capsule, and turns the head forward into the acetabulum. As extension is made the dislocation will be found to have been reduced (Bigelow, Kocher).

Reduction is really effected by the traction employed and not by manipulation, as is generally supposed. The traction must be continued while the outward rotation is made.

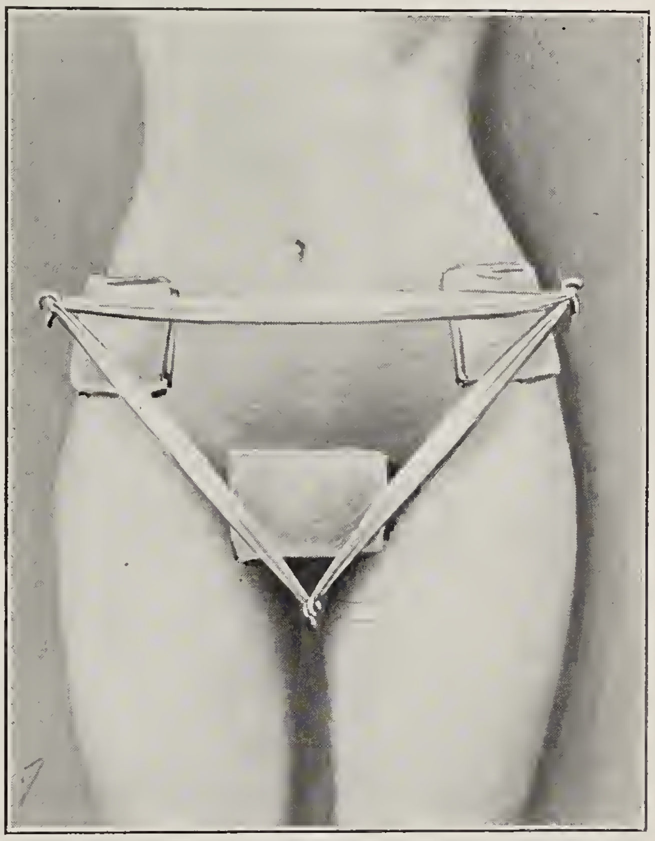
FIG. 760.—ALLIS'S FIXATION APPARATUS.

Care must be exercised not to convert the dislocation into one of the obturator variety. This may occur from excessive abduction and outward rotation. Should this occur, the head of the bone is to be lifted on to the edge of the acetabulum by drawing directly upward on the flexed femur. When the head is felt to have engaged in the capsule, a snapping noise and a corresponding sensation indicating this, simple extension is to be made, when reduction will be found to have been effected.

During all these maneuvers the pelvis must be held firmly so that it cannot follow the movements of the femur. In fact, the whole secret of easy reduction of dislocations at the hip-joint lies, according to Oscar H. Allis, in firm **fixation of the pelvis.** This surgeon demonstrates the ease with which reduction may be effected even in cases in which a fracture below the trochanter complicates the procedure, the fragments being held together only by a delicate strip of periosteum, provided sufficient care has been taken beforehand to fix the pelvis firmly.

The maneuvers for reduction described for the cadaver are to be employed in the living subject. Two large screw-eyes are to be screwed into the floor at proper distances, the anesthetized patient placed between these, and the pelvis firmly fixed by a number of turns of a broad muslin bandage which passes back and forth through the screw-eyes and across the front of the pelvis, including the iliac spines and the pubes. It is not possible for an assistant to hold the pelvis so firmly as it is held with this device of Allis (Fig. 760).

Stimson's Method.—This surgeon employs a method of reduction which commends itself for convenience. The patient is placed face downward on a table with the affected thigh hanging over its end. The other limb is held in a horizontal position by an assistant (Fig. 761). The surgeon grasps the ankle of the affected side, the knee being flexed at a right angle. The necessary traction in the desired direction is made by the weight of the limb itself, sometimes aided by the weight of a small sand-bag at the knee or by slight pressure by the surgeon's hand. The surgeon has only to wait for the muscles to relax and the bone to resume its place without further effort on his part other than slightly rocking or rotating the limb. An anesthetic is not always necessary.

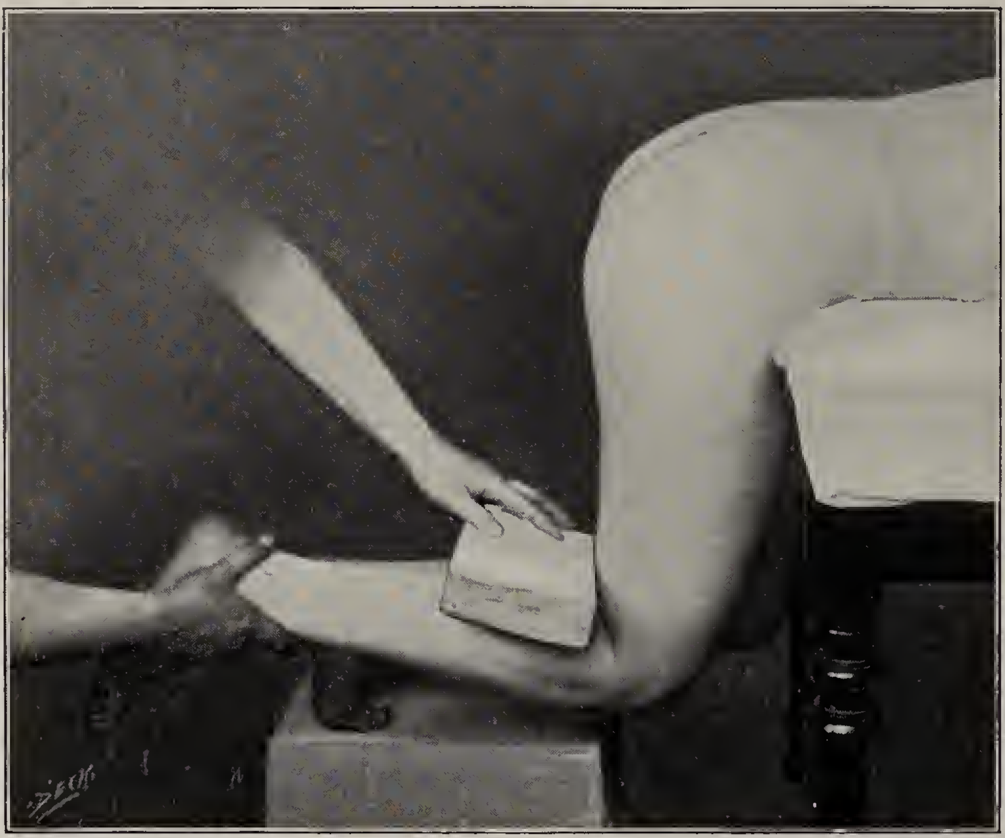

Fig. 761.—Stimson's Method of Reduction of Dislocation of the Hip-joint.

Allis has simplified our studies of dislocations of the hip by classifying them as displacements (1) in an inward direction or on the pubo-ischiatic plane; (2) in an outward direction or on the ilio-ischiatic plane. Reduction in both cases is effected in two stages. The head is first brought into as close relation as possible with the acetabulum. Pressure is then made by the hands of an assistant, while the operator, utilizing these as a fulcrum, pushes the head of the bone into the acetabulum. The pelvis should be firmly strapped to the floor (Fig. 760). In dealing with a dislocation **inward** the thigh is flexed to a right angle and traction made in an outward direction by the bent knee. The assistant's fingers are pressed deeply into the groin, and with these as a fulcrum, continuing the traction, the surgeon raises the knee to a right angle and carries it obliquely toward the pubes. In dealing with an **outward dislocation** the thigh is flexed as before and upward traction made by the flexed knee. As the head of the bone rises to a point immediately below the acetabulum, a forward movement of the surgeon's body is made, the traction being still continued, and the assistant grasps the thigh with both hands, his thumbs being pressed firmly just above the trochanter. The operator employing this pressure as a fulcrum, and still making traction, brings the limb into complete extension.

In the after-treatment of the dislocation the patient should be kept in bed for a fortnight, when he may be allowed to make careful attempts at walking.

Obstacles to reduction in recent cases are rare. Experimentally, the most frequent of these has been shown to be a transverse rupture of the capsule close to the neck of the femur, the capsule acting like a curtain between the head and the acetabulum (Gellé). A still rarer obstacle is the presence of broken-off cartilage from the edge of the acetabulum.

Old dislocations are best left undisturbed after failure of reduction by manipulation. The use of the pulleys will not be likely to succeed and may do harm. It is surprising to what extent the function of the limb is finally restored in cases of old unreduced dislocations. **Resection of the head of the femur** is rarely called for. It is indicated only where pressure against the sciatic nerve at its point of exit from the pelvis causes extreme pain or paralysis of the lower extremity.

Pathologic dislocations may occur in the course of specific fevers as the result of articular inflammations or they may occur from rachitic changes in the bones. (See also Tuberculous Inflammation of the Hip-joint.) Prolonged flexion and adduction of the limb may produce dislocation in a normal joint. The process is a gradual one and usually occurs without pain other than that incident to the diseased condition on which the dislocation depends. **Paralytic** or **myopathic** dislocation of the hip is rare.

Obturator and Perineal Dislocations.—Obturator or thyroid dislocations are the second of the dislocations of the hip in order of frequency. They are, in all probability, the first stage in the production of some of the suprapubic as well as some of the dorsal dislocations. The head of the femur, leaving the acetabulum at its lowest part with the limb in forced flexion, is turned either backward behind the acetabulum by adduction and internal rotation, or forward and upward by external rotation and extension. The manner in which an obturator dislocation may be produced in an attempt to reduce an iliac dislocation by excessive abduction and outward rotation has already been discussed.

With flexion alone present the head of the femur moves directly downward below the acetabulum. Such an influence of the dislocating force is exceptional, and even should it occur the remaining portions of the capsule and the tense muscles would be quite unlikely to leave the head in a position exactly at the lower edge of the acetabulum resting on the tuberosity of the ischium, though such cases have been reported (see Infracotyloid Dislocations), neither abduction nor adduction being present, but pronounced flexion (Bonn and Malgaigne). Forced flexion and abduction, on the other hand, may force the head into the obturator foramen, producing an **obturator** or **thyroid (infrapubic)** dislocation. There also occurs here a secondary movement of extension, the extremity occupying a moderately flexed but abducted position. With extensive rupture of the capsule further dislocation takes place and the head is forced near the tuberosity of the ischium and perineum, this constituting a **perineal dislocation** (Fig. 764). In these cases the capsule may be extensively detached from the acetabulum at its inner and posterior insertion, and the Y-ligament partly separated from the neck of the femur (Shaw). The thigh may be flexed and abducted so as to stand out from the body, making an angle of from 60 to 70 degrees with the sagittal and frontal planes (Stimson) (Figs. 762 and 763).

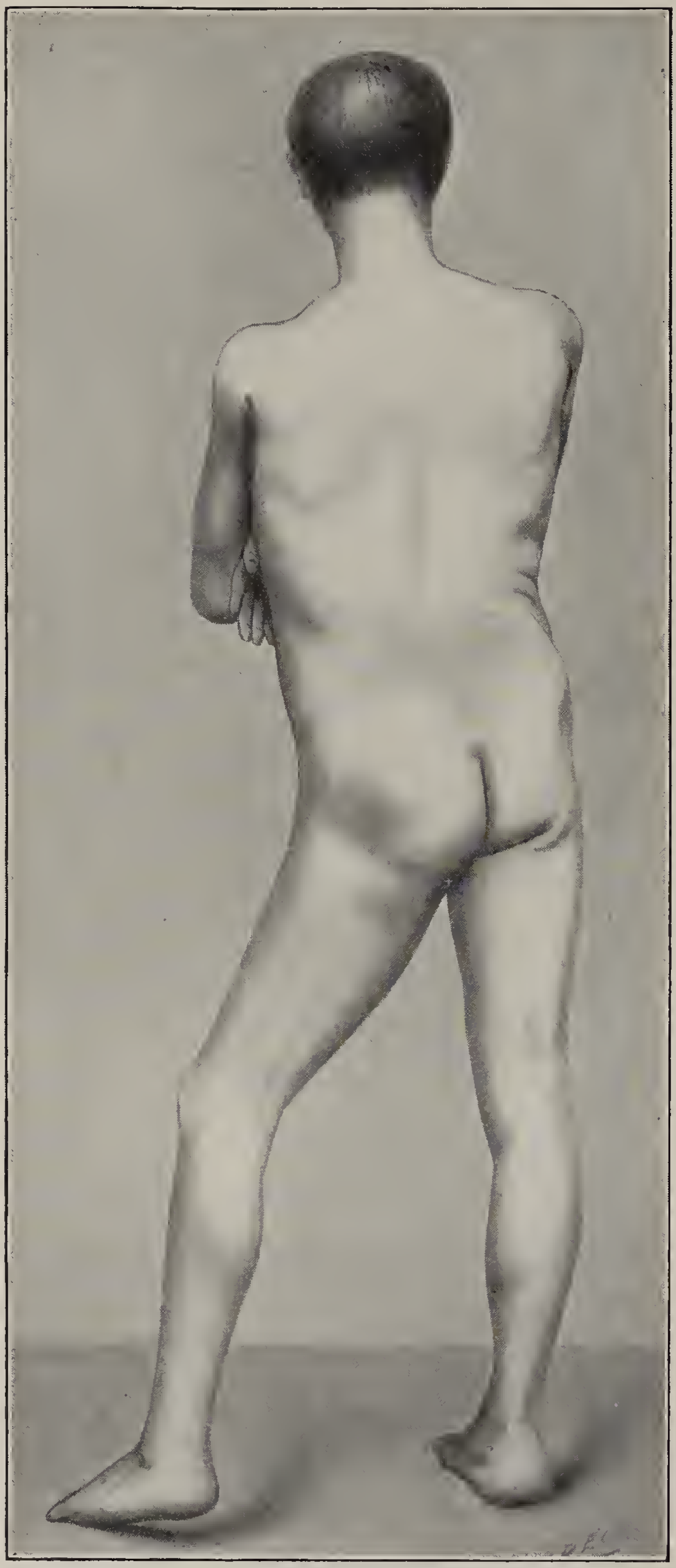

Fig. 762.—Obturator Dislocation, Posterior View (from Stimson).

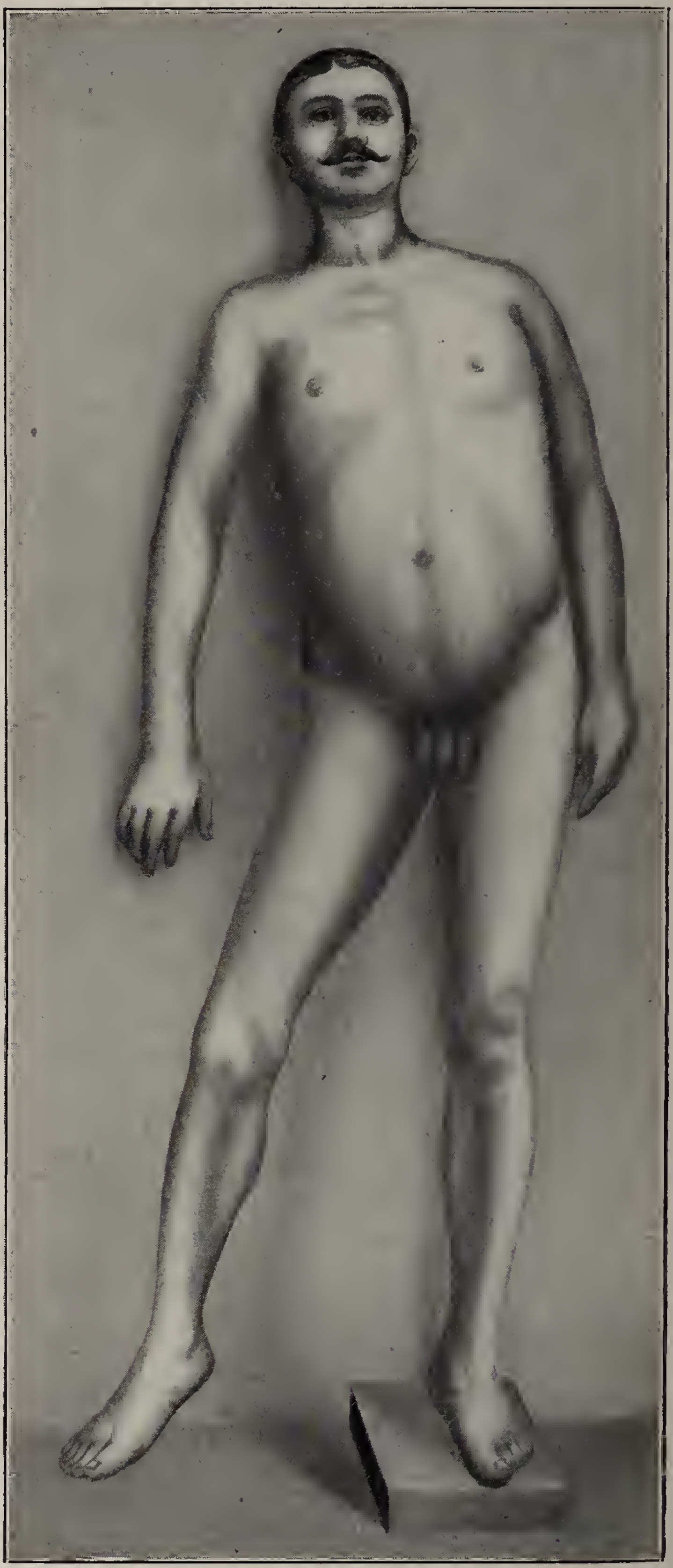

Fig. 763.—Obturator Dislocation, Anterior View.

These injuries arise most commonly from great violence applied on the back of the pelvis while the limb is flexed and abducted, as, for instance, when a workman is stooping forward with his limbs separated, as in the act of shoveling ("cave-in" accidents in sand pits). Simple abduction may also produce it, as in the case reported by Corne of a drunken soldier whose thigh was forcibly abducted by his comrades; and also cases reported by Keate and Barker, in which forcible separation of the thighs was the cause (Stimson). In Barker's case both thighs were dislocated.

Diagnosis.—The attitude of the limb is striking. It is flexed and abducted, and usually rotated outward. There is apparent lengthening due to the compensatory tilting of the pelvis forward and downward on the same side in the attempt to bring the foot to the ground (Figs. 762 and 763). This attitude, together with depression of the trochanter and the presence of the head in its new position, will serve to establish the diagnosis. It is sometimes difficult to determine the position of the head on account of swelling and effusion of blood. Outward rotation is also present in fracture of the neck of the femur, but in the latter there is shortening instead of apparent lengthening.

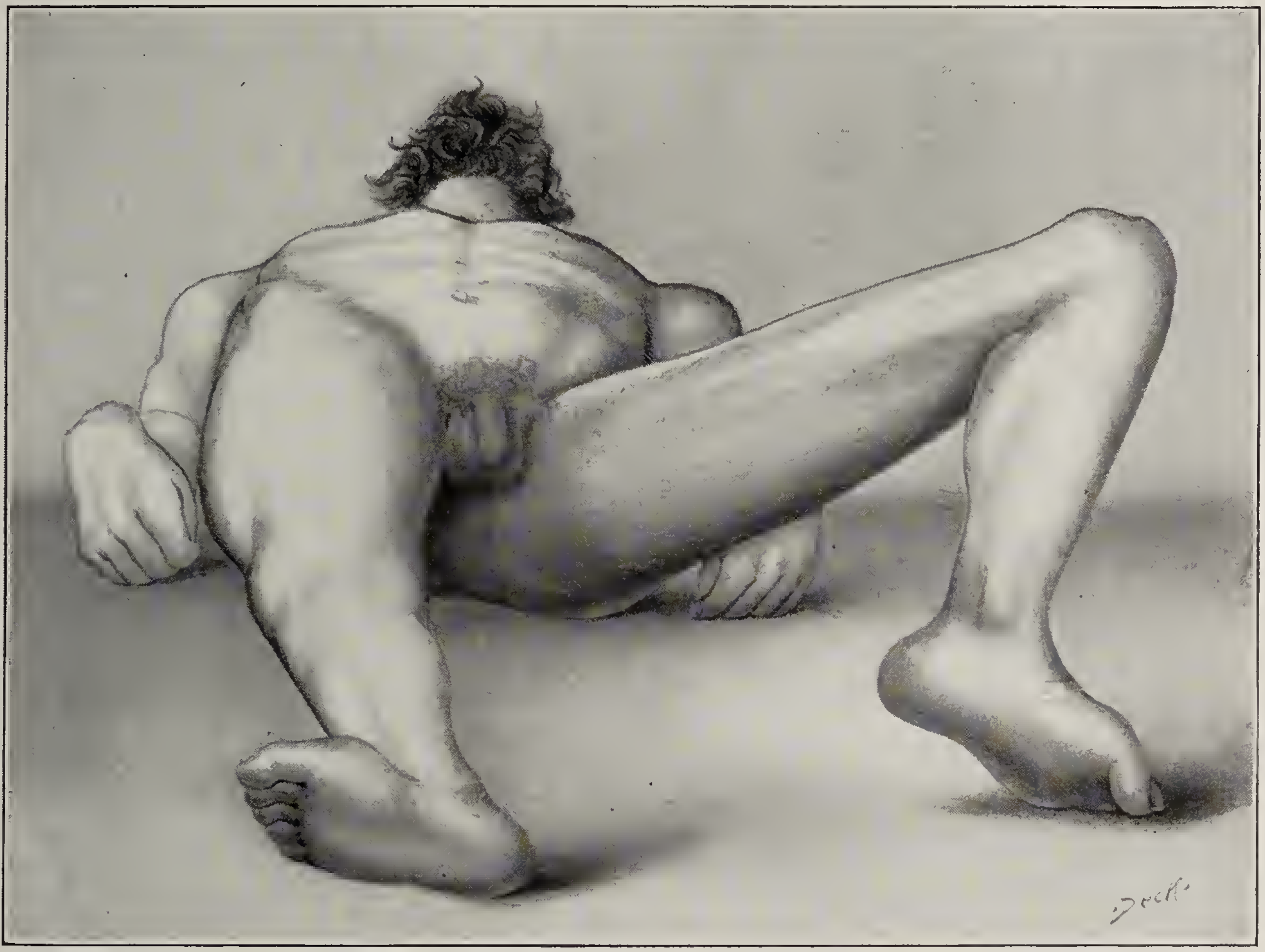

FIG. 764.—PERINEAL DISLOCATION (AFTER BIGELOW).

The steps in the procedure for reducing obturator dislocations, formulated by Kocher and based on Bigelow's work, are as follows:

1. **Flexion of the Thigh to a Right Angle with the Pelvis.**—The abduction and outward rotation in which the limb is found must be preserved during this maneuver, which relaxes all parts of the capsule.

2. **Traction.**—This produces tension of the posterior part of the capsule and brings the head nearer the acetabulum.

3. **Outward Rotation.**—This, acting through the tense posterior portion of the capsule and outer branch of the Y-ligament, forces the head of the bone upward and backward into the acetabulum.

Reduction has been easily effected by increasing the flexion and rotation, making traction on the long axis of the limb and then lowering and rotating inward (Stimson). Continuous traction in the axis of the limb, combined with lateral elastic traction on the upper part of the thigh, was successful in a case of four weeks' standing, which had resisted all other methods (Kocher). Finally transformation into a dorsal dislocation, and reduction as such, has been recommended (Bigelow). In cases of long standing it may be necessary to **excise the head and trochanter** (MacCormac).

Perineal dislocations are reduced by **simple flexion and traction** (Stimson).

Pubic, Iliopectineal, and Intrapelvic Dislocations.—These are what are known as **extension dislocations,** and they are of much rarer occurrence than flexion dislocations for the reason that, while flexion forces the head of the bone against the thinnest and weakest portion of the capsule, forcible extension forces it against the strongest portion. Two forms are recognized, namely, dislocations from **hyperextension and abduction** and **dislocation from hyperextension and adduction.** In the first the head of the bone is forced against the pubofemoral ligament, rupturing this and passing on to the horizontal ramus of the pubis, so that a **pubic dislocation results.** In the second form the head, after rupturing the strong iliofemoral band, rests in the neighborhood of the iliopectineal eminence below the anterior inferior spinous process of the ilium, this constituting the **iliopectineal** dislocation. Of the two ligamentous bands involved in these dislocations the iliofemoral is by far the more resistant, and therefore the last named form of dislocation, involving as it does rupture of this ligament, is very rare. The pubic variety has been confounded with obturator dislocations, and the iliopectineal has been described under the name of supracotyloid. In rare instances the head has been forced beneath Poupart's ligament (intrapelvic or subpectineal dislocation, Scriba, Bartels).

Shortening, extension, outward rotation, and abduction are the most essential symptoms of these dislocations. Inward rotation and adduction may be present in cases in which Poupart's ligament is torn and the head of the bone rises above that point (Robert and Scriba). The head of the femur is felt in the groin. In the pubic variety the vessels lie on its outer side; in the iliopectineal the vessels lie directly in front of the head of the bone or to the inner side of it. There is flattening of the posterior and outer portion of the thigh in both varieties; the trochanter lies in front of the acetabulum. Abduction is possible and sometimes easy; adduction is difficult or impossible. Eversion and shortening are present in fracture of the neck of the femur; hence, this dislocation should not be confounded with that injury. The differential diagnosis is made by noting the presence of the head in the groin, the flattening of the outer aspect of the thigh, and the depression of the trochanter.

The crural nerve is sometimes affected by the dislocated head of the femur; in other instances the femoral artery and vein are curved forward and compressed.

The reduction is easy, as a rule, the extensive tearing of the capsule which makes these dislocations possible lessening greatly the difficulties of reposition. The general rule that, before reduction is attempted, the limb should first be placed in the position which it occupied when the dislocation occurred, is not suitable in these dislocations, since it may do damage to the vessels by overstretching these across the projecting head of the femur. Bigelow's method consists essentially of flexion of the thigh (the position in which it already lies) combined with traction in the axis of the limb and inward rotation. Pressure is made on the head of the bone to prevent this from passing in an upward direction during flexion. This is sometimes known as Kocher's method, but it is one of the methods originally described by Bigelow.

In the more decidedly marked pubic cases the bone may lie so near the symphysis as to render it necessary to make abduction of the limb during traction in order to relax the still intact outer band of the Y-ligament, and thus to permit the head to approach the acetabulum. Should the head slip into the obturator foramen during the movement of flexion, the dislocation should be treated as if of that variety, since, in such a case, the upward dislocation was originally one of the latter.

Supracotyloid or Subspinous Dislocations.—A great deal of uncertainty exists as to the nature and extent of this lesion, the point at which the head has passed through the capsule and the mode of production. Blasius collected 25 cases that he believed were well characterized examples of this dislocation, but it is more than probable, as stated by Stimson, that some of these were really cases of the everted dorsal, as well as other varieties, in which the head of the bone had reached nearly the same position by passing outward after primary dislocation forward and upward on the pubis. In fact, some writers assert that a direct origin of this dislocation is improbable (Hueter, Lossen).

In this dislocation the head passes directly upward and is found above the acetabulum, usually to the outer side of the anterior inferior spine and below the anterior superior spine. In one case reported the bone lay below and to the inner side of the anterior superior spine. Bigelow suggests that the powerful external portion of the Y-ligament is ruptured in this dislocation; Stimson believes the essential feature to be a rupture or avulsion of the upper part of the Y-ligament.

The mode of production cannot be definitely stated. In two cases in which the lesion was proved on autopsy the character of the accident is stated; in one the patient fell from a ladder; the dislocation remained unreduced for twenty-six years, the patient in the meanwhile having good use of the limb (Wormald). The other was a machinery accident in which the patient was whirled around a revolving shaft many times.

The **diagnosis** is usually easily made, the head being felt in its abnormal position without difficulty.

In the **reduction** it would be important to know whether the dislocation was a direct or a secondary one. If the former, the proper mode of reduction should be from the hyperextended position (Behrend). Experience shows that this method does not succeed. Roser by experiment on the cadaver showed **hyperflexion with inward rotation** to be the proper procedure. In Stimson's case reduction was easily effected by flexing the hip about 20 degrees and then making moderate traction along its axis with one hand at the knee and direct pressure downward and backward on the head of the femur with the other hand. By reversing these movements the dislocation was readily reproduced.

Infracotyloid Dislocation.—This is very rare except as a transitory primary dislocation, occurring preliminarily to either a dorsal or an obturator one. The cause is the same as that of many dislocations of the above varieties, though exaggerated abduction followed by slighter flexion appears to be also capable of producing it (Roux).

Reduction in the cases reported has been effected either by making traction in the axis of the limb, with or without direct pressure on the head of the bone, or by first transforming the dislocation into a dorsal or an obturator one and then reducing it.

FRACTURE OF THE NECK OF THE FEMUR

This may occur from direct force, as, for instance, in gunshot injuries. Usually, however, the fracture occurs from indirect force in various ways. In falls from a considerable height, the patient striking on his feet with the knee extended, the force is transmitted through the rigid extremity to the angularly placed femoral neck, which gives way in spite of the archlike arrangement of the cancellous tissue designed to resist force in this direction. When, in consequence of atrophy of the cancelli, this arrangement of the structure of the neck is interfered with, fracture occurs readily. In elderly persons, and in women, fracture from falls in a lateral direction is frequent, probably in consequence of the relatively horizontal position of the neck of the bone. It was formerly supposed that such fractures occurred from blows on the trochanter major. It is more probable, however, that the giving way of the bone occurs after overstretching of the ligamentous structures about the hip-joint, particularly the iliofemoral ligament, the fracture corresponding to the insertion of the ligament and hence lying outside the capsule.

Extracapsular Fracture and Intracapsular Fracture.—A great deal of stress was formerly laid on this distinction, the former being supposed to unite always by bone, while the latter usually united by connective tissue (ligamentous union). The exact relation of the line of fracture in relation to the insertion of the capsule is not of so much importance as the variations in the point of insertion of the capsule itself, many fractures being partly within and partly without the capsule.

Circumstances other than the point of insertion of the capsule are probably to a great extent responsible for failure of union by bone, such, for instance, as the interposition of a portion of the iliopsoas muscle between the fragments, and considerable displacement of the fragments, particularly that of the upper end of the lower fragment in a backward direction (Maxwell, Ruth), the absence of vessels in the periosteum investing the neck of the femur, defective nutrition resulting in spite of the presence of the vessels of the ligamentum teres, which according to Hyrtl do not even pass to the medullary tissue of the head of the femur, the age of the patient, and grave constitutional disturbances. Still it is undoubtedly true that fractures with line of separation well outside the capsule have a better callus formation, and, particularly in young subjects, unite firmly by bone, the archlike arrangement of the cancellous structure being restored.

Impacted Fracture.—The distinction between this and nonimpacted fracture is important as to diagnosis, prognosis, and treatment. Impaction is usually produced by the forcing of the cortical structure of the concave side of the neck (Adam's femoral arch) into the broad spongy tissue between the trochanters (fracture of the surgical neck). In rare cases the cortical structure of the lower fragment is driven into the spongy tissue of the head of the femur (fracture of the anatomic neck). In impacted fracture bony union may occur, whatever location the line of fracture occupies.

Incomplete Fracture.—This differs from impacted fracture in that, while in the latter the line of fracture is complete, separation does not occur; in incomplete fracture only one wall of the femoral neck gives way, the other being simply bent. The senile atrophy of the cortical lamellae, resulting in conditions resembling those found in young bones, favors this variety of fracture. Marked deformity may be absent though slight abduction or adduction may occur.

Intertrochanteric Fracture.—In this variety an oblique line of fracture passes in a direction from above and outward, and downward and inward, the trochanter major and the upper portion of the shaft being separated from the trochanter minor and the remainder of the shaft. Here the periosteum is completely efficient and bony callus is formed.

Fracture of the Dislocated Head of the Femur.—This arises from the influence of a force resulting from the falling of the patient to one side after a backward and outward dislocation of the head of the bone. Reduction of the dislocation is not possible until consolidation of the fracture has taken place, and even then it may fail, refracture occurring during the attempt. Under these circumstances the establishment of a false joint at the point of refracture in the callus formation gives a comparatively good functional result. Should failure of callus formation follow the fracture, the head of the bone may be removed.

Crushing of the Acetabulum and Forcing of the Head of the Femur into the Lesser Pelvis.—This is of rare occurrence and can result only from the exhibition of an enormous force. Double vertical fracture of the pelvic ring and dislocation of the acetabulum together with the head of the femur is of rather more frequent occurrence.

Fracture of the Trochanter Major.—Exclusive of gunshot injuries, this is of rare occurrence. The fragment is usually drawn upward and backward by the action of the gluteal muscles, considerable diastasis taking place and ligamentous union resulting unless the malposition of the parts is corrected by bone suture or by the use of an ivory peg.

Diagnosis and Prognosis of Fracture of the Neck of the Femur.—A nonimpacted fracture of the neck of the femur is usually easily recognized by the following symptoms: (1) Shortening. This depends on contraction of the muscles which pass from the pelvis to the femur. Its exact extent can be ascertained by the location of the trochanter major. (2) **Outward rotation of the limb.** This results from the weight of the foot and the action of the external rotator muscles of the thigh (glutei, pyriformis, gemelli, quadratus femoris, obturator internus). Rotation inward has been exceptionally observed. In Smith's case the lower fragment was displaced on the anterior surface of the upper one. (3) **Passive rotation** of the limb. This is possible only in the longitudinal axis of the limb instead of at the short lever of the cervix femoris around the center of the head, as in the normal. Of these, the first two are the most important. In sciatic and iliac dislocation shortening is present but outward rotation is absent. In obturator dislocation outward rotation is present but shortening is absent. In the rarer forms of dislocation (suprapubic, iliopectineal, and supracotyloid) the displaced head is usually easily recognized. Age is likewise an important factor (see Dislocations of the Femur). The thigh is flexed in sciatic and iliac dislocations and extended in fracture. Finally, the presence or absence of crepitation, ease of reduction in fracture, and difficulty of reposition in dislocation will facilitate the differential diagnosis.

In impacted fracture the most important of the above symptoms are absent. The shortening is limited to less than an inch. Outward rotation is usually present, though it may be but slight. Passive rotation may be accomplished, particularly external rotation, though the attempt is accompanied by pain. Complete inward rotation is generally impossible. Crepitation cannot be obtained without first separating the fragments, always a most unjustifiable procedure. But one trustworthy sign, and this obtainable only in thin individuals, namely, that of approximation of the trochanter major to the acetabulum due to shortening of the cervix femoris, remains. In slight impaction this may escape detection. It is better to err on the safe side and treat a case of severe contusion of the hip for fracture than *vice versa*.

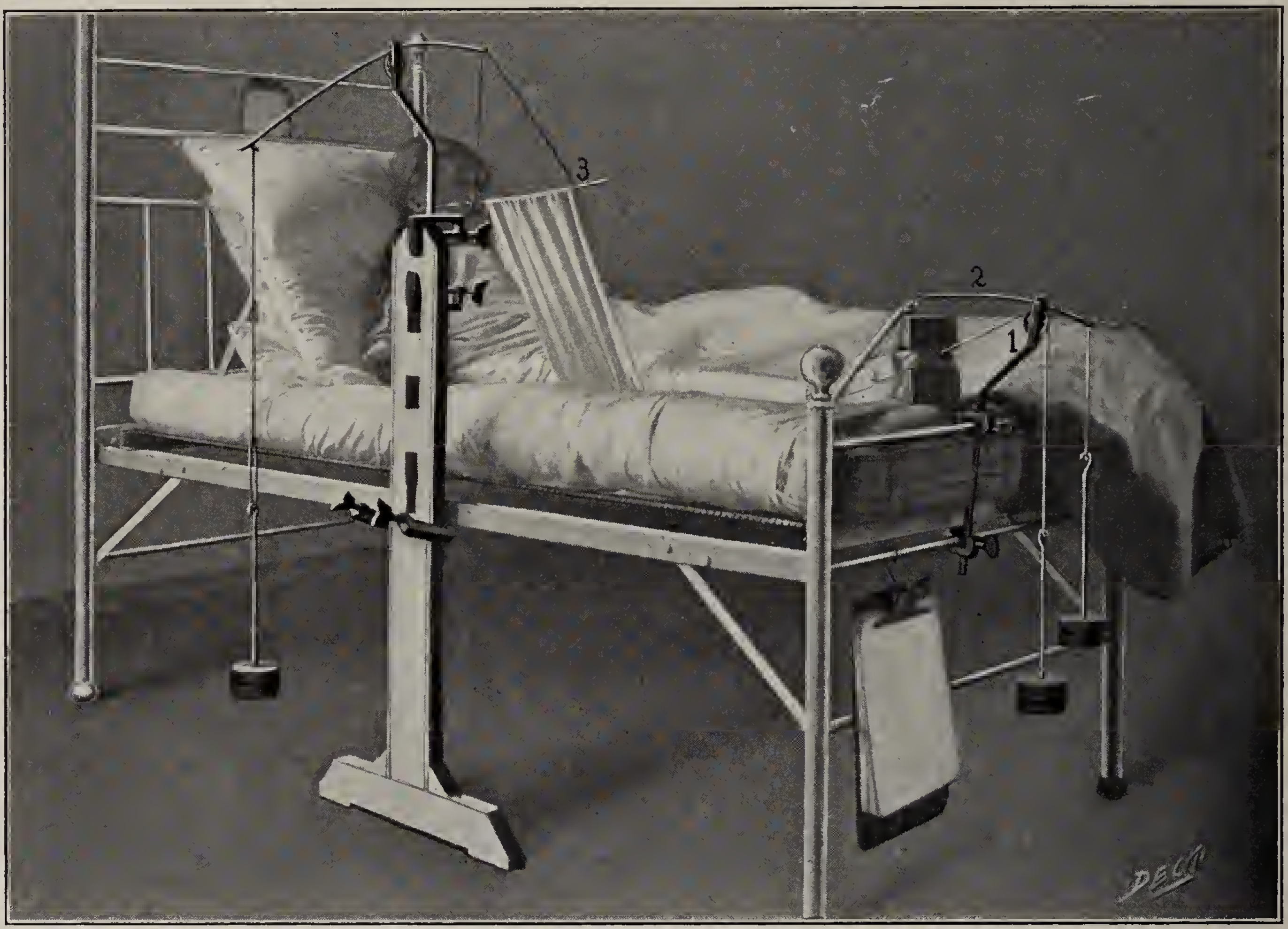

FIG. 765.—RUTH'S EXTENSION APPARATUS.
1, Buck's extension in the long axis of the limb; 2, lifting arrangement for relieving the pressure on the heel; 3, lateral extension and inward rotation apparatus (Ruth).

The **prognosis** is divided into functional and vital. In elderly patients a good functional prognosis can be given only in cases of impacted fracture, and even then this must be qualified. In ununited nonimpacted fracture the fibrous connection is not sufficient to bear the patient's weight, and he will generally be compelled to walk with artificial support. Finally the presence of the callus may interfere with proper movements of the hip-joint.

The vital prognosis relates specially to elderly persons. A preceding bronchitis is likely to prove fatal. The prone position of the patient favors the supervention of hypostatic bronchitis and pneumonia. In rare instances suppuration of the injured joint occurs, in which case a fatal result usually follows.

Treatment.—Disentanglement of any portion of the iliopsoas muscle that may have become interposed between the fragments should be assured by first flexing the thigh on the abdomen and then making traction, at the same time bringing the limb to the extended position. Restoration should be maintained by means of weight and pulley extension (Buck, Fig. 767). This may be supplemented by a broad band of adhesive plaster arranged on the thigh so as to lift the latter to the proper level, and at the same time counteract the outward rotation (Maxwell, Ruth) (Fig. 765). The strips of adhesive plaster (preferably the moleskin plaster of Maw) to which the weight is attached should pass well up on the thigh and be secured by circular turns of a bandage. Counter-extension is secured by elevating the foot of the bed. Sufficient weight to overcome the spasmodic action of the muscles is to be employed. If this weight exceeds 18 pounds, it must be reduced as soon as practicable, or the adhesive strips so arranged as to make the traction entirely from above the knee. A long side splint extending from the axilla to a point several inches below the sole of the foot, with a cross-bar to prevent rotation of the limb, and in addition a "railroad" splint (Fig. 767) are useful. If these means are not employed, sand-bag supports on each side of the

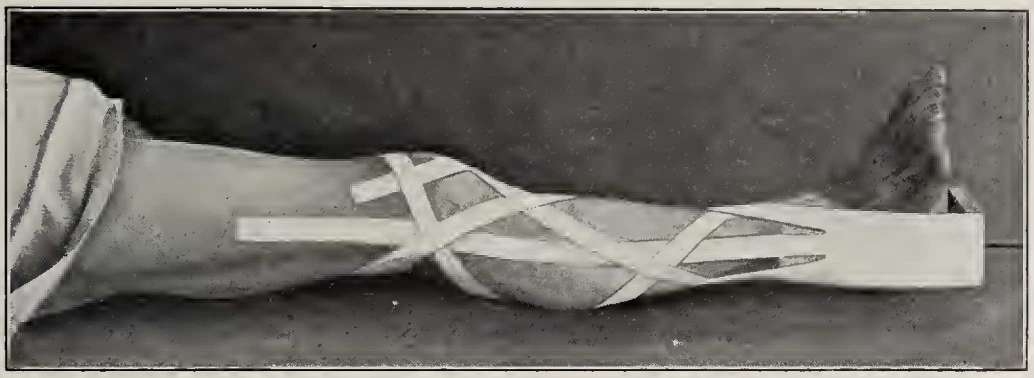

Fig. 766.—Adhesive Plaster Strips Arranged for Buck's Extension.

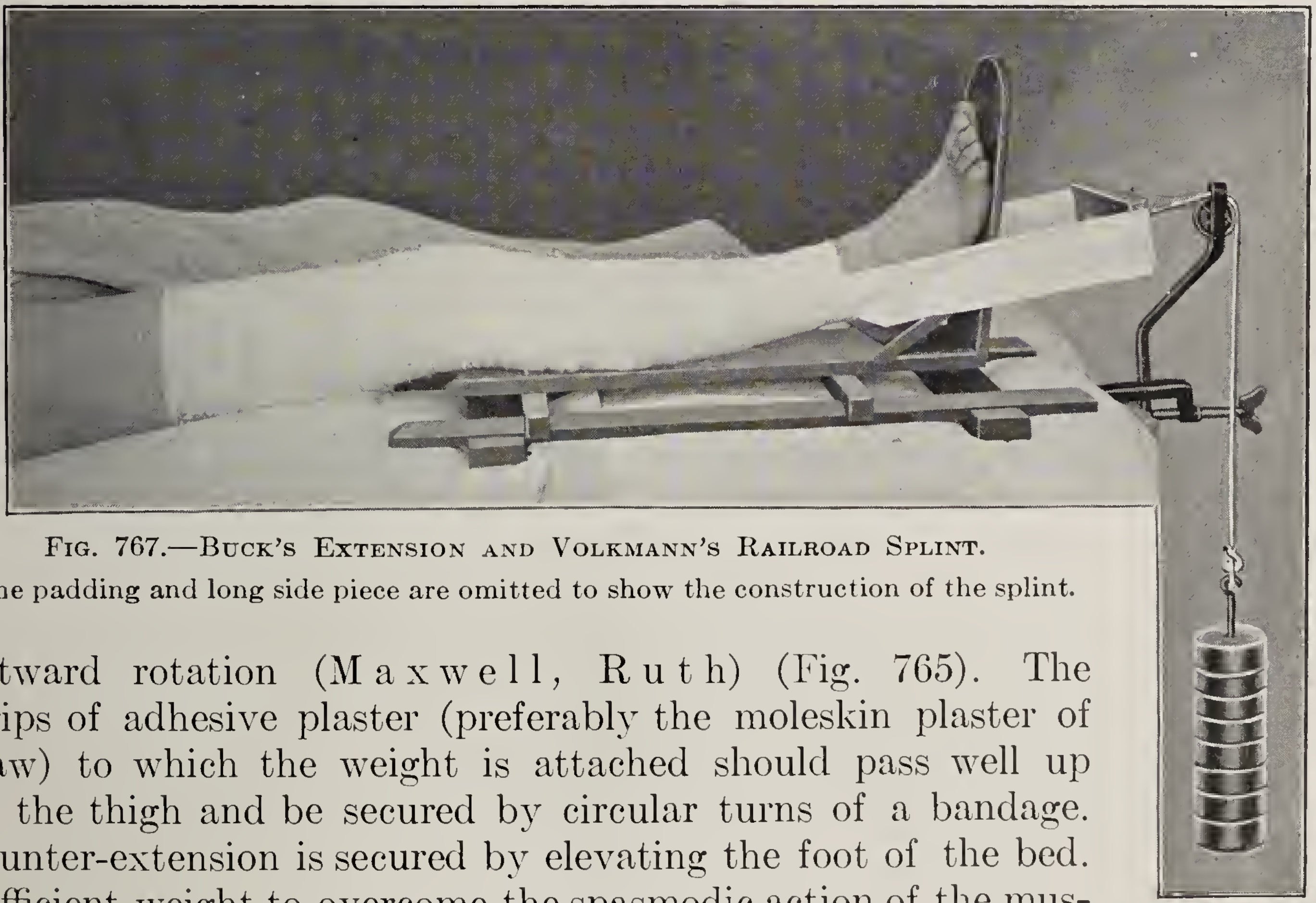

Fig. 767.—Buck's Extension and Volkmann's Railroad Splint.

The padding and long side piece are omitted to show the construction of the splint.

limb will be necessary. In some instances Bardenheuer's method of overcoming outward rotation by means of cross-traction strips of adhesive plaster will be necessary (Fig. 768). In impacted fracture, but slight traction will be needed after the spasmodic action of the muscles has been overcome.

Volkmann recommended the double inclined plane in fracture of the neck of the femur. The weight and pulley extension may be added to this (Fig. 769).

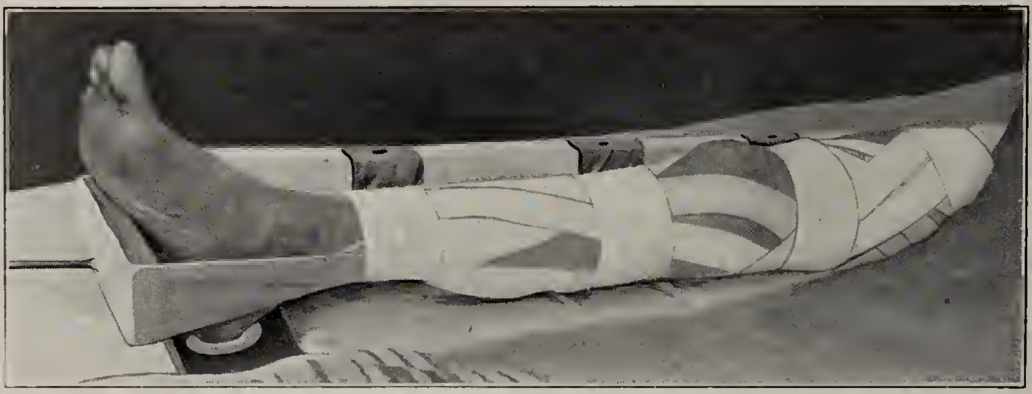

Fig. 768.—Buck's Extension, with Bardenheuer's Rotation Strips Encircling the Limb and Fastened to the Long Side Splint, for Overcoming Rotation of the Femur.
Showing also the heel resting on the cross-bar, with "doughnut" ring support between.

Langenbeck, and later Senn and König, attempted the operative treatment of securing the fragments by means of a metal screw or nail driven into the upper fragment from the trochanter major. The method is not without danger in old people, and in young people it is unnecessary.

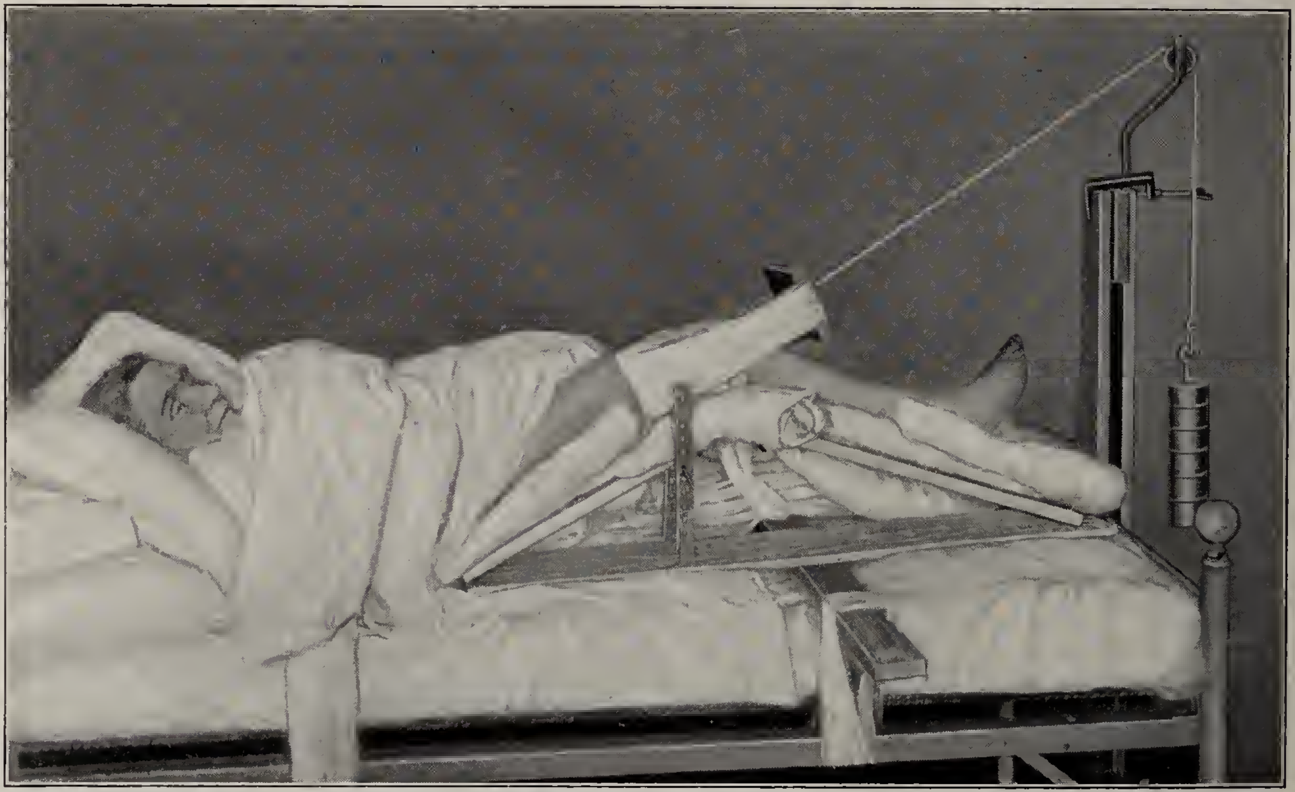

Fig. 769.—Fracture of the Neck of the Femur.
Double inclined plane and weight and pulley extension.

The dangers arising from keeping elderly patients in bed for a protracted length of time led Astley Cooper, and after him Allis, of Philadelphia, to treat such patients by means of crutches, the weight of the limb acting as a counter-extending force. A still further improvement on the method is the use of a Thomas's or Taylor's hip-joint splint (see page 527). Finally, all attempts at securing union will have to be abandoned in the case of certain old and weak patients.

GUNSHOT INJURIES OF THE HIP-JOINT

Missiles striking at right angles to the surface within the boundaries of an irregular triangle, whose base is at the trochanter major and whose sides cross each other at an acute angle at the anterior superior spinous process of the ilium, will invade the hip-joint. The ball may perforate or crush the osseous structures if the entrance occurs from an inch to an inch and a half below the anterior superior spine, the joint being directly implicated. If the wound of entrance is in front of the trochanter major or behind it, the neck of the femur will be injured and the capsule torn at its insertion. A gunshot-wound of the buttocks, the ball striking the latter in an oblique direction, may be complicated with an injury to the hip-joint. Balls passing obliquely into the pelvis may crush the acetabulum from the inner side. The neck of the femur may be completely separated by the missile, in which case symptoms of fracture will be present; generally, however, complete separation does not occur, a furrow being made by the ball in its passage, or the capsule only being torn.

In addition to noting the location of the point of entrance of the bullet, which should be at once enlarged, when necessary, to admit of exploration, the surgeon will observe acute swelling of the joint. This generally occurs in the flexure of the thigh, is deeply placed and situated on the outer side of the great vessels. When due to hemorrhage into the joint, it will occur within a few hours. If, on the other hand, it is due to serous effusion, the accumulation will occur in the course of a day or two. In either case a suppurative coxitis rapidly supervenes, accompanied by septic fever. The mortality under these circumstances is high, a large proportion of the cases succumbing to septic infection.

Treatment.—Resection of the joint should be performed at once, both for the purpose of thoroughly cleansing it and for the sake of affording efficient drainage. In this way only can the grave sequels be avoided. The mortality from primary resection will be found to be in direct proportion to the delay in instituting the operative procedure.

Ankylosis and contracture of the hip-joint may follow extra-articular gunshot wounds.

HIP-JOINT DISEASE

This is preeminently a disease of childhood; it very seldom occurs, however, before the third year of life. After this age, it is distributed somewhat evenly during the period of the growth of the bones, being rather more frequent between the fifth and the tenth year than between the tenth and the fifteenth year. At the termination of this period it decreases gradually.

The disease commences as a tuberculous osteomyelitis in either the acetabulum or the femur, both of these portions of the skeleton being by preference predisposed to the affection. This predisposition on the part of the acetabulum is explained by the fact that, in childhood, the three bones of the pelvis which join at the acetabulum are separated by three cartilaginous lines, representing epiphysial lines. In the femur, a portion of the upper limit of ossification of the diaphysis projects into the area of the capsule at birth; the epiphysial line advances gradually into the area of the synovial insertion, finally becoming inclosed with the articular surfaces constituting the joint. With the well-known tendency of the epiphysial lines to become infected during the growing age, when young bony tissue is always present, it is not difficult to understand the reasons for the frequency of coxitis in childhood. The infection in the great majority of instances enters by way of the blood, and develops as a slowly progressive tuberculous osteomyelitis, or more rarely as a sudden septic infection, causing suppurative osteomyelitis. Tuberculous coxitis originates more frequently at the acetabulum than at the femur (Oberst's statistics from Volkmann's clinic).

As the osteomyelitis advances to the surface of the bone **synovitis** occurs which is at first serous in character; this afterward assumes all the characteristics of tuberculous synovitis. This, in turn, unless the disease is arrested at this point, gradually develops into a **suppurative inflammation.**

Inflammation of the hip-joint as it occurs in adults is usually metastatic in its origin (**metastatic coxitis**). It occurs in general pyemia following the infectious fevers and the puerperal state. In these cases there is a more rapid development of the suppurative form of inflammation.

Inflammation originating in the soft parts very rarely affects the hip-joint, except in the case of gunshot or punctured wounds involving the tissues next to the joint.

In some cases primary tuberculosis has its origin in the trochanter major, and may not involve the joint.

Symptoms.—The **tuberculous coxitis** of childhood commences with but slight symptoms and develops very slowly; it advances, however, in the course of months, to a stage when pronounced and dangerous symptoms are present. The first noticeable symptom is a **slight limp,** which, in the course of time, becomes so marked that the entire limb takes part, and the child drags the limb instead of walking on it.

In many cases no further distinctive symptoms are present during the first or **initial stage** of the disease. In fact, the child is not usually brought to the surgeon until the limp has continued for some time. Even then there is, as a rule, nothing definitely discoverable on examination; and, unless a suspicion of hip-joint disease is awakened and the parents put on their guard, serious results, which might otherwise have been averted, will follow. The limp at this time is probably due to a sense of uncertainty of the affected limb.

The next symptoms of the initial stage are **pain and tenderness.** These in some cases appear in connection with the more pronounced limp or "drag of the limb"; they appear, however, some weeks after the limp is first noticed. Pain is felt when walking, and **is worse at night,** often being so severe as to awaken the child and cause it to cry out (**night terrors**). In children old enough to localize the pain, complaint is made of the region of the hip and also frequently of the knee-joint. This **eccentric pain** at the knee, occurring in the commencement of the disease, has been the cause of many diagnostic errors, its presence directing attention to the knee-joint. It is generally thought to be due to irritation of the obturator nerve, the posterior branch of which sends a filament to the hip-joint, the anterior branch terminating on the skin on the outer side of the knee-joint. In just what manner this irritation is produced does not appear. Or it may be due to irritation of the crural nerve, which supplies articular branches to both the hip and knee.

Tenderness on palpation is present in the **second initial** stage of the disease. This may be developed by pressure over the femoral vessels, where the finger-tips may be forced directly on the neck and head of the femur; also by pressure on the trochanter major, which forces the head of the bone into the acetabulum as in walking.

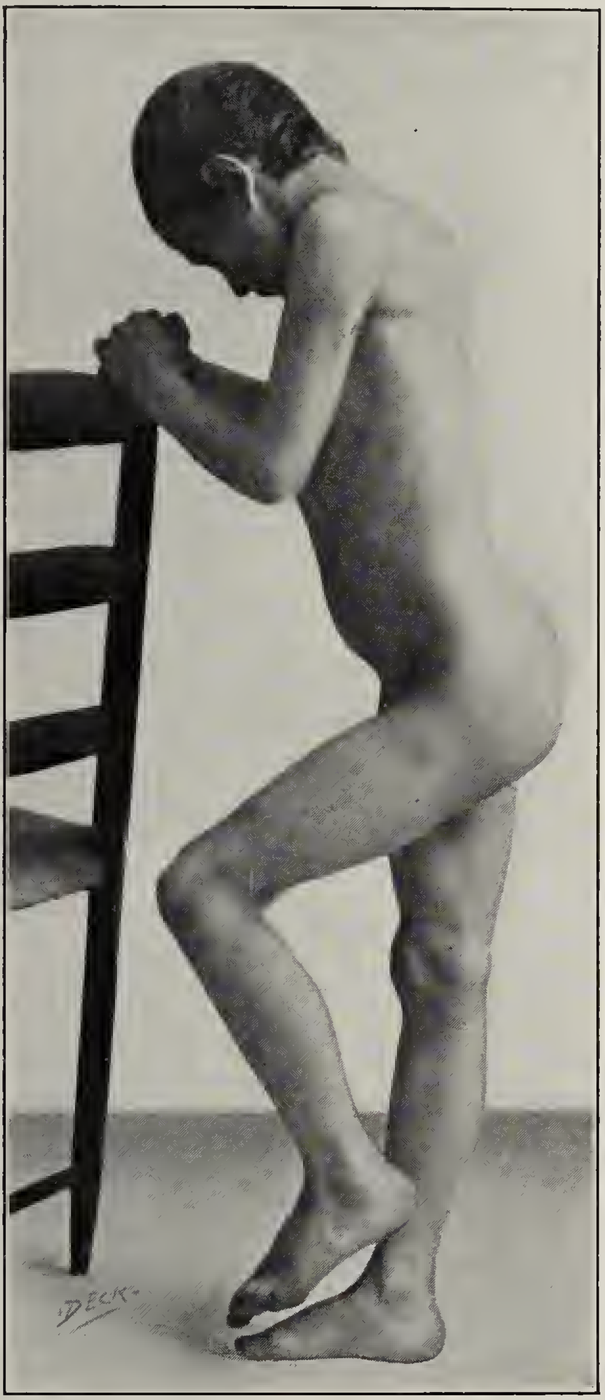

Fig. 770. — Position in Hip-joint Disease, Side View.

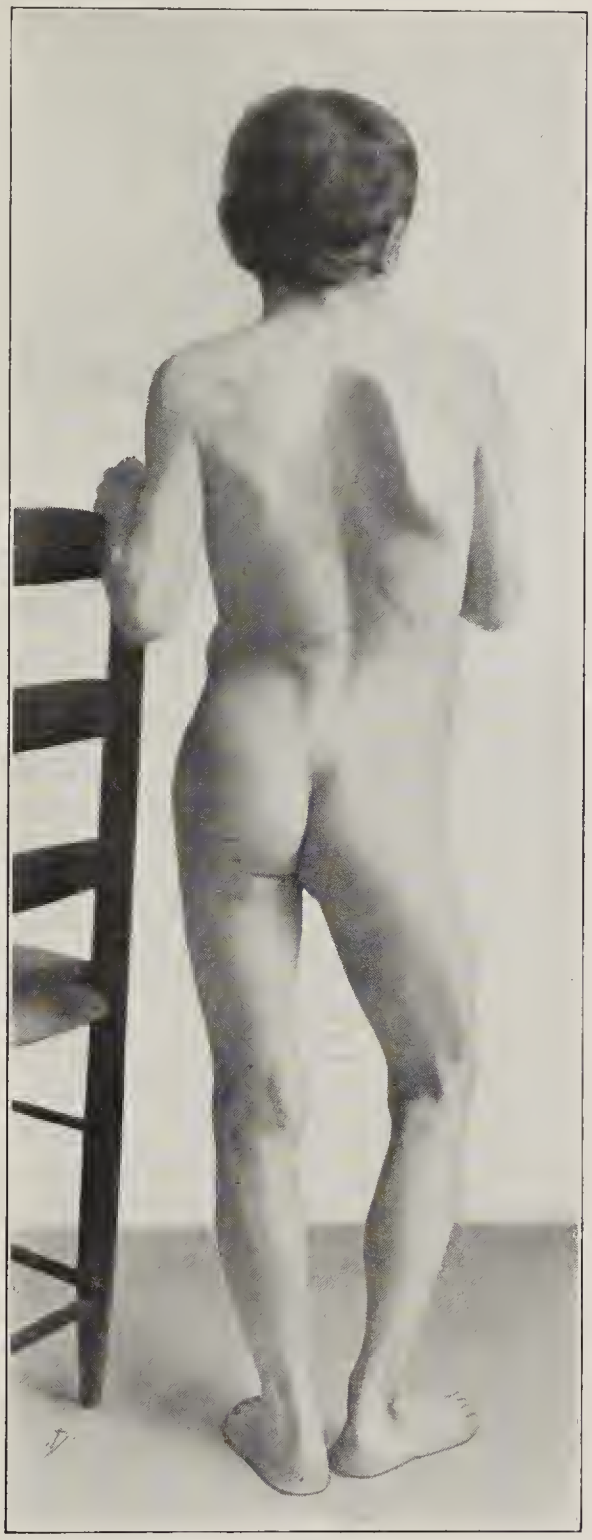

Fig. 771. — Position in Hip-joint Disease, Rear View.

In this stage also **limitations of movements** are observed. This is first shown by restriction of movements in rotation with the limb extended; this is purely an effect of the pain upon the muscles, these contracting by reflex when sensitive portions of the capsule are stretched. All the muscles moving the hip-joint soon take part in these reflex contractures, and hence all movements are restricted. That these limitations of movements are purely muscular at this time is shown by the fact that, under a general anesthetic, every movement is restored.

As soon as the entire synovial lining of the capsule takes part in the inflammatory process the limb assumes a characteristic attitude (Figs. 770 and 771). This is a result of a combination of three physiologic movements, **flexion, abduction,** and usually more or less **rotation.** This attitude is explained by the fact that the flexion relaxes the psoas muscle and prevents pressure of its tendon on the front of the joint, and abduction releases the tension on the fascia lata and thus relieves the pressure on the joint, which is normally exercised through pressure of the fascia lata on the great trochanter (Allis).

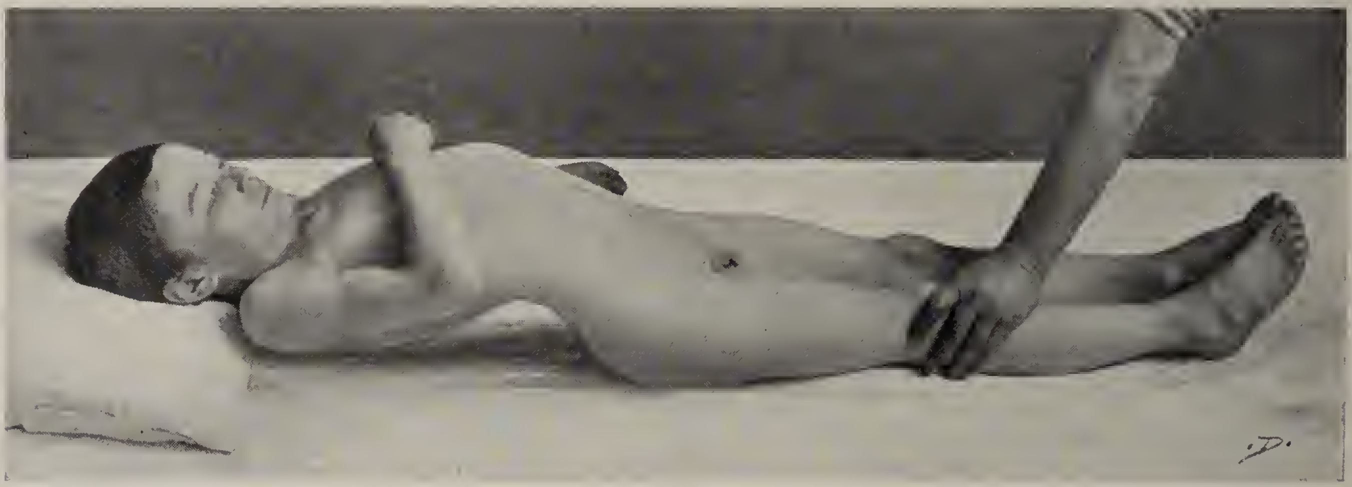

FIG. 772.—EFFECT ON LUMBAR SPINE OF EXTENDING DISEASED LIMB IN HIP DISEASE.

The diagnostic attitude is frequently overlooked early in the disease on account of the correction instinctively made by the patient by the **tilting of the pelvis.** The femur, when flexed to an angle of 30 degrees, is no longer able to steady the trunk, the entire weight being thrown on the other limb. In order, therefore, to relieve the diseased joint from pressure by standing on the other limb, and at the same time to preserve an equilibrium, the pelvis is tilted so as to lengthen the limb. The spine follows this flexed position of the pelvis, and in order to preserve the center of gravity in the proper line the lower portion of the spine is bent backward, **compensating lordosis in the lumbar region** being thus produced. Thus flexion of the thigh is compensated by tilting of the pelvis, and this, in its turn, is compensated by lordosis of the lumbar spine. In advanced cases these signs are readily seen at a glance (Figs. 772 and 773), but early in the disease they may pass unrecognized. In order to bring

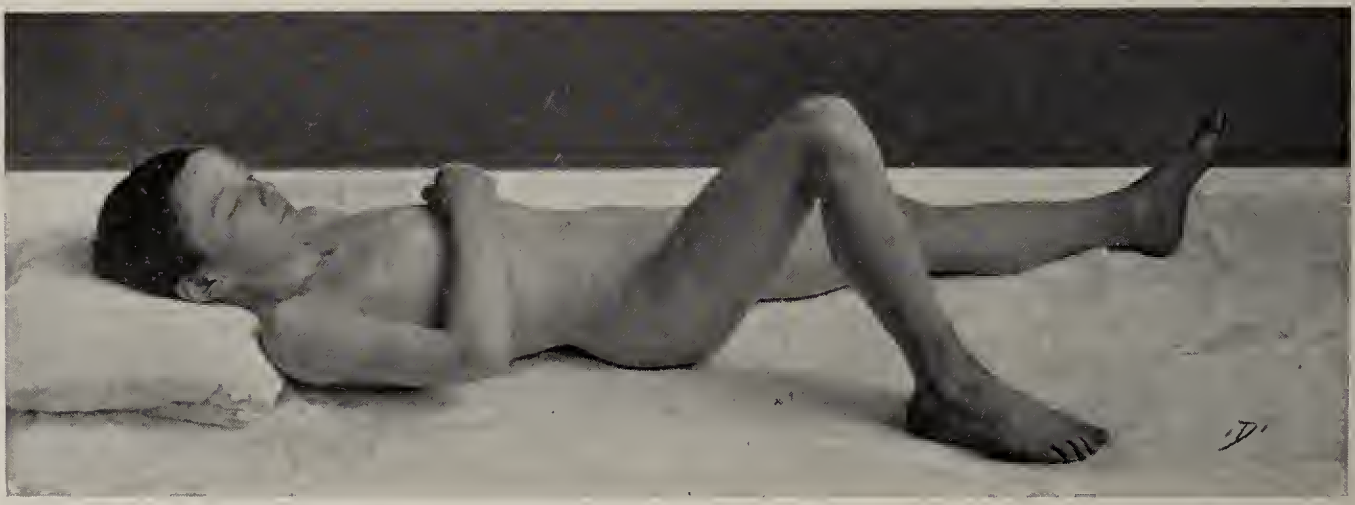

FIG. 773.—EFFECT ON THE LUMBAR SPINE OF FLEXING THE LIMB IN HIP DISEASE.

them out clearly the child is placed in the recumbent position on a table and attempts made to bring the limb into complete extension. The tilting or flexion of the pelvis is here still maintained, though no longer necessary to preserve the equilibrium, for the reason that to abandon it would be to make painful pressure on the front of the capsule. Therefore, in order to permit the limb to be extended, the child involuntarily tilts the pelvis forward. At the same time the lumbar spine brings out the lordosis, by leaving the surface of the table. A reversal of the movement till the lumbar spines touch the latter will show the precise amount of flexion of the thigh present in the case. In order to demonstrate the influence of abduction in relieving pressure on the joint, it is necessary only to attempt forced or superadduction with the patient still in the recumbent position. As soon as the limb is brought inward to its fellow or laid over it, the pelvis at once tilts laterally in order to relax the fascia lata which the adduction makes tense.

Apparent Lengthening.—The belief that lengthening due to effusion in the joint exists in the early stage of hip-joint disease can no longer be entertained. There is no appreciable lengthening, though Hueter taught that this did occur to a slight extent and was due to overgrowth at the diseased upper epiphysis, the result of the inflammatory irritation. Apparent lengthening is due to asymmetry, as can be shown by measuring the limbs with both placed in equal degree of flexion and abduction (Allis).

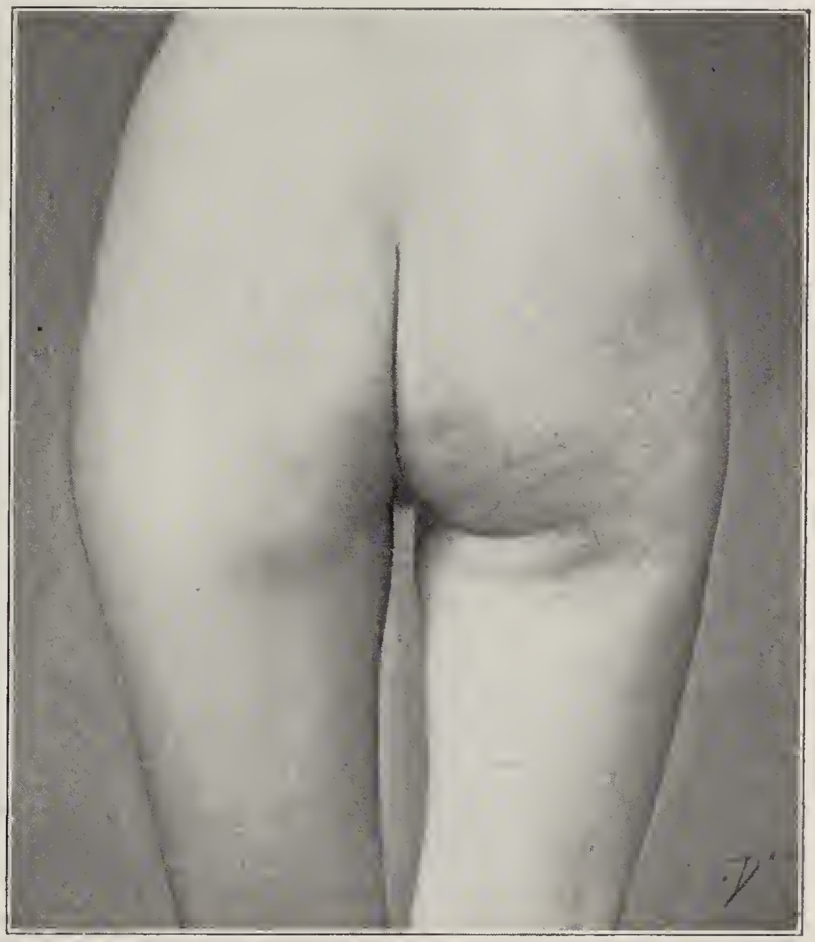

Fig. 774.—Showing Effacement of the Gluteal Crease.

As the disease advances new symptoms are developed due to granular tuberculous synovitis, accompanied by involvement of the other tissues of the capsule and those in the neighborhood, and by consequent destructive processes. The hip is widened; the superficial tissues are soft and edematous, and the deeper ones are firmer, this constituting the appearance known as **tumor albus coxae.** The swelling replaces the wasting of the limb due to atrophy of the muscles, the normal outlines of which are lost as shown by the obliteration of the gluteal crease (Fig. 774).

There is increase of pain and sensitiveness. The patient gives up attempts to walk and dreads being disturbed. The child lies in bed on the opposite side with the limb sufficiently flexed to relieve all pressure of the psoas. The well thigh is flexed in order to form a support for the other limb, which is now changed from the position of abduction to that of adduction, with the knee also flexed, inward rotation replacing outward rotation, as naturally occurs in health when this position is assumed in sleeping. With these changes in the attitude of the limb the patient is enabled to rest comfortably on the other limb.

If, after assuming this position for a time in bed, the patient is lifted to the upright position it will be found that the flexion is increased in spite of added compensating lordosis in the attempt to lessen still further the pressure of the psoas on the anterior portion of the capsule, and that the abduction and inward rotation replacing the formerly existing abduction and outward rotation, which were established for the purpose of resting the limb comfortably in bed, are maintained. The explanation of this lies in the fact that the psoas muscle, in its course from origin to insertion, follows an oblique direction from within outward, and that adduction and inward rotation of the limb serve to approximate still further its two extremities and assist the flexion in relieving pressure on the joint. These changes in the position of the limb release the downward tilting of the pelvis, and this is replaced by a return to its normal position or by an upward tilting with **apparent shortening** of the limb. **Suppuration** may or may not have occurred up to this point.

As the disease progresses **actual shortening** takes place, referable to different causes. These occur, in the order of frequency, as follows:

1. **Inflammatory Involvement of the Acetabulum.**—This is the most common cause of shortening of the limb. It occurs most frequently in a backward and upward direction. In cases in which the acetabulum is primarily affected, this **recession of the acetabulum** may occur early; in those instances in which the disease commences in the femur, it follows the ensuing granular osteomyelitis. In any case the head presses against the posterior and superior edge of the acetabulum, producing atrophy of the softened medullary tissue. With rapid development of this atrophy the acetabulum soon loses its shape, and the articulating surface of the head of the femur may leave the socket. In most cases, however, the rarefying process is a slow one, and atrophy of the layers most exposed to pressure is accompanied by hypertrophy of the more peripheral portions which are still irritated by the inflammation, but not exposed to pressure. Thus the original edge of the acetabulum is destroyed, and a new one formed by periosteal proliferation. This in its turn may be destroyed and still another edge form during the process. The enlargement may, though rarely, take place in the direction of the obturator foramen (Blasius, Hueter). In case the limb remains in slight flexion and pronounced abduction for a long time, the head may advance toward the inner edge of the acetabulum.

2. True **inflammatory dislocations of the head of the femur,** formerly believed to be so common that they constituted a special stage of the disease, are now known to be very rare. They do occur, however, the edge of the acetabulum becoming lower because of atrophy, the head of the femur at the same time becoming atrophied and flattened. This is a true **pathologic dislocation,** the flattened head luxating over the flat edge of the acetabulum upward and backward on the posterior surface of the ilium. Sometimes the head remains on the edge of the acetabulum. These two forms, namely, dislocation from recession of the acetabulum, and pathologic dislocation of the head of the femur, differ only in the more sudden occurrence of the latter, and the absence of a newly formed acetabulum. The occurrence of inflammatory dislocation is favored by a rapidly acute attack of the disease. Still rarer is

dislocation dependent on dilatation and loosening of the capsule by accumulation of serous or purulent fluid occurring in cases of infectious fevers, in which the head passes over the intact edge of the acetabulum. With total destruction of the joint and its ligamentous environment, dislocation may easily occur.

3. **Inflammatory separation** of the head of the femur in the upper epiphysial line is probably more frequent than inflammatory dislocation. The suppurative process advancing from the diaphysis is checked at the epiphysial line by the slightly vascular cartilaginous tissue. The intervening cancellous tissue is destroyed, and practically the same conditions obtain as in fracture of the neck of the femur. Owing to the intracapsular location of the epiphysial line this separation is accompanied by suppuration within the capsule, and the loosened and necrotic head of the bone, insufficiently nourished by the vascular supply through the ligamentum teres, lies as a sequestrum in a large abscess of the hip-joint. Healing may follow the opening of the abscess and removal of the head. The same process, occurring in the course of a chronic form of the disease, may give opportunity for **fusion of the head with the articulating surface of the acetabulum** before the separation at the neck occurs.

If, in the course of an attack of hip-joint disease, the **trochanter major is found to be markedly above its normal situation,** as shown by its relation to the ischioiliac line or to Bryant's test line, one of the three conditions above described exists.

4. Slight shortening may be due to **inflammatory atrophy of the head and neck of the femur.** While complete destruction of these may occur, it is restricted, as a rule, to a slight extent.

5. Finally, **inhibition of growth** by destruction of new-formed bony tissue near the epiphysial line, and interference with the function of the latter and consequently the growth of the bone at this point, will result in shortening. This **relative shortening** is most appreciable late in the disease, and sometimes only after the latter has subsided. It is progressive in character as long as the bones continue to grow, and while the affected bone continues to increase in length, with its lower epiphysis intact, it does so at a slower rate than its fellow. The final discrepancy in the length of the two limbs will depend on the age of the individual when attacked by the disease. The younger the child, the greater the shortening when adult age is reached, and *vice versa.*

It is difficult to estimate beforehand the probable relative shortening, since the rate of growth at the upper epiphysis as compared with that at the lower is not the same at all ages. Up to the fifth year of the child's life the growth of the femur takes place about equally at both ends; after this age the rate of growth at the lower epiphysis increases till it finally becomes three times that of the upper (Ollier).

A slow suppurative process accompanies the granular osteomyelitis and synovitis of hip-joint disease; sudden suppuration of the whole joint occurs but very rarely. The pus soon finds its way into the parasynovial connective tissue, burrows between the different muscular layers, and finally points on the surface. Fistulous openings form, which lead to the diseased bone by long and circuitous routes. The inflammation now subsides, but as long as carious bone remains the fistulas persist. Even should these close at the skin surface, accumulations of pus occur in the depths with recurrence of the symptoms and repointing or the formation of fistulous openings elsewhere for the discharge of the pus. Permanent healing occurs only with the removal of the sequestrum or its expulsion either *en masse* or as broken-down detritus.

In cases in which the focus of pus at the site of the osteomyelitic infection invades the joint early in the disease, a large abscess of the joint forms which perforates the capsule, is rapidly diffused in different directions, and finally reaches the surface at several points. Owing to the fact that the thinnest portion of the capsule is situated posteriorly, these are usually situated behind at different points of the gluteal region, from the crest of the ilium to the trochanter major and tuberosity of the ischium. Fistulous openings are rarely found at the anterior and inner portions of the thigh, for the reason that this location represents the place where the synovial lining of the joint is well guarded by the thickest portions of the capsular ligament, as well as by muscular structures. The fistulous openings in these cases heal with difficulty, owing to the fact that the joint itself is a constant source of infection, and obliteration of this takes place with difficulty without operation. Tuberculous infection of the gluteal muscles and neighboring fascial structures is liable to occur. Once healed, they may remain so for months or even years, only to break down again into profuse suppuration. Should the suppuration persist for a long time a low but persistent fever develops, with amyloid degeneration or miliary tuberculosis.

The clinical picture of ordinary hip-joint disease differs greatly from that of **acute suppurative coxitis** the result of acute osteomyelitis. The latter leads to separation of the upper femoral epiphysis. But the ordinary form of tuberculous coxitis may become converted into a sudden general suppuration of the joint, accompanied with rigors and rise of temperature. The prognosis of acute suppuration of the hip-joint is unfavorable, whether it follows chronic hip-joint disease or acute osteomyelitis.

Tuberculous infection of the iliac glands occurs in a certain proportion of cases from secondary infection. The chain of glands accompanying the external iliac artery, the external iliac glands, are specially liable to become involved from the acetabular affection. With the patient's lower abdominal muscular wall relaxed by raising the shoulders, the inflammatory mass may be felt by palpation with the finger-tips pressed deeply just above Poupart's ligament. The infection from these glands may extend to the deep inguinal glands and finally point in the upper portion of the thigh. On opening the resulting abscess freely the finger may be passed into the pelvic cavity.

The Differential Diagnosis of Hip-joint Disease.—Only a careless observer will mistake hip-joint disease for lymphadenitis of the groin, or for inflammation of the knee-joint. The latter error is of the more frequent occurrence, particularly in the beginning of the disease. There are two affections, however, which may be mistaken for this disease in spite of close observation. These are (1) **suppuration of the gluteotrochanteric bursa mucosa;** (2) **psoas abscess** or diffuse phlegmon in the lower portion of the iliopsoas.

The **gluteotrochanteric bursa mucosa,** from one and a half inches to two inches long and from three-fourths of an inch to one and a half inches wide, lies between the trochanter major and the broad tendon of the gluteus maximus. It communicates with the intermuscular spaces at two or more points, specially in the direction of the gluteus maximus and the quadratus femoris; suppuraation in the bursa may extend in either of these directions. Fistulous openings in this neighborhood, though usually due to hip-joint disease, may be attributable to suppuration in this bursa. When accompanied by abduction and outward rotation to relieve the tension of the gluteus maximus, together with impaired movements at the hip, which occur in this affection, the symptoms are still more suggestive of hip-joint disease. Insensitiveness of the joint itself, however, will settle the question as to the hip-joint, and enlarging the openings and exploring the suppurating cavity with the finger will reveal the source of the suppuration.

In psoas abscess tension on the muscle is always painful, hence extension of the femur is impossible and the hip-joint is flexed. As the trochanter minor, the place of insertion of the psoas muscle, is made to approximate the point of origin of the latter by outward rotation of the femur, this movement also takes place. A still further resemblance to hip-joint disease is thus produced. Finally, with inability of the patient to walk, swelling in the region of the hip, and the appearance of an abscess below Poupart's ligament, a superficial examination may easily lead to error. On the other hand, in every apparent case of coxitis **the dorsal and lumbar regions must be carefully examined for posterior curvature** or **kyphosis** with reference to the existence of tuberculous osteomyelitis of the bodies of the vertebrae, or **Pott's disease,** to explain the possible existence of a psoas abscess due to this cause. Hip-joint disease may be excluded in other cases of psoas abscess by pressure of the hip-joint in Scarpa's space and against the trochanter. **Sacrocoxitis** is scarcely likely to be mistaken for hip-joint disease.

Coxitis of Adults.—This may give rise to the same symptoms as the disease in children. If not dependent on an injury, coxitis in adults is usually dependent on tuberculous disease, which, it is fair to assume, is a symptom of general tuberculosis. Acute suppuration in the hip-joint is most often the result of infection in the course of pyemia, or one of the infectious fevers. Finally, **synovial polyarthritis** may attack the joint in either an acute or a chronic form.

In advanced life hyperplastic panarthritis or **arthritis deformans** causes disturbance of function only. A certain amount of hyperplastic panarthritis takes place in cases of fracture of the neck of the femur, but even without the irritation produced by traumatism the hip-joint takes part relatively frequently and early in general arthritis deformans. The head of the femur is thickened, its globular head becomes elliptic, and the surface is roughened. The cartilage becomes thickened and projects at the junction of the neck with the head. The capsule also becomes thickened and the synovial surface papillomatous. The cartilage finally disappears, and the head atrophies. The symptoms are slight in proportion to the changes which take place in the parts involved, and consist of inability to execute full movements of the joint, crepitation, and inability to walk far; acute pain is rare; there is no swelling or fever. Suppuration rarely develops. The treatment consists in warm baths and methodic passive movements, inunctions of ointments of potassium iodid, and the administration of the salicylates.

Prognosis of Hip-joint Disease.—**Danger to life** is threatened in this disease by the following: (1) The rapid occurrence of a hyperacute tuberculous synovitis, followed by suppuration. Total suppuration of the joint is an exceedingly grave condition under these circumstances, particularly in cases in which perforation of the acetabulum takes place and the abscess empties itself into the loose connective tissue of the lesser pelvis, septic fever developing and proving rapidly fatal. In other cases the patient rallies at first, but succumbs subsequently to general pyemic infection. Even those who escape these dangers in this class of cases rarely make a complete recovery. (2) The supervention of general miliary tuberculosis, tuberculous meningitis, pneumonia, amyloid degeneration of the abdominal organs or kidneys, and chronic pyemia and general asthenia.

Impairment of function results either from **shortening,** which, unless very slight, always causes a limp, or from **contracture** and **ankylosis** in the hip-joint (Fig. 775). The extent of the impairment of function is subject to the varying circumstances of destruction of the joint and the position in which the limb is left when the disease is arrested. In cases indubitable in character the recovery may be so complete as to leave no trace of the former disease. The most troublesome contractures are those which occur while the limb is in the position of flexion, adduction, and inward rotation. Walking is very difficult in these cases. The lordosis in the lumbar spine and a **compensatory kyphosis in the dorsal region,** combined with flexion, adduction, and inward rotation of the limb, produce a most striking attitude. These patients are compelled frequently to give up attempts at walking altogether and to depend on crutches.

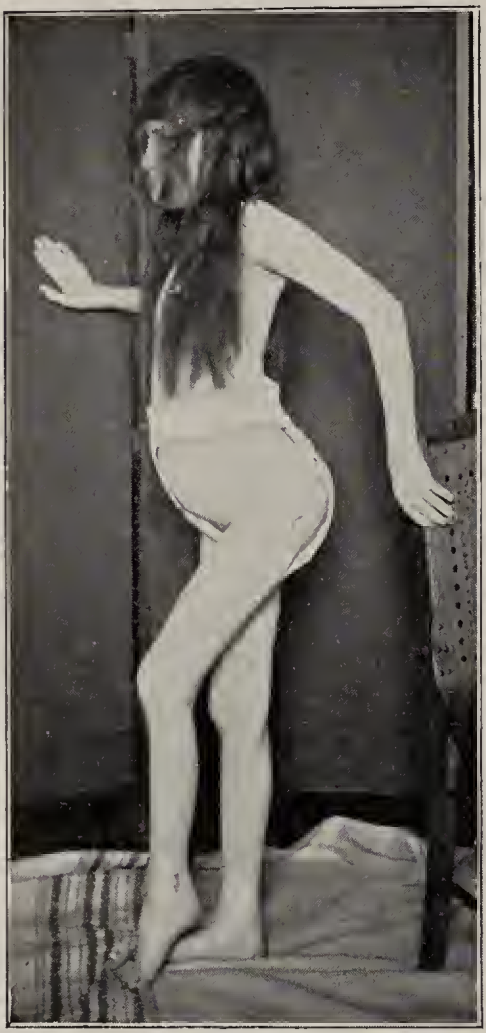

FIG. 775.—CHARACTERISTIC ATTITUDE OF PATIENT WITH HIP-JOINT DISEASE.
Faulty ankylosis following cure.

The Early Treatment of Hip-joint Disease.

—If treatment is commenced in the early stage, the prognosis is favorable in the great majority of cases. Too often, however, the significance of the early symptoms is underrated, and valuable time is lost.

It is a rule, to which there should be no exceptions, that every case at all suspicious in character should be given the benefit of the doubt and treatment instituted. The child should be put to bed, and **absolute rest** insisted on. In addition, tonic measures must be employed, such as the preparations of iron and codliver oil; guaiacol and creasote should also be given. Above all things, the diet must be rich and nourishing. The patient should be given the benefit of the air out-of-doors as much as possible when the weather permits, and residence at the seashore is preferable. The favorable experiences of Calot at Berck-sur-Mer show to what extent these measures are valuable, even in advanced cases. Under all circumstances, however, the **recumbent position must be maintained** at this time. The tonic régime and dietary must be persisted in during the entire course of the disease. and for some time after all symptoms have disappeared.

As soon as pains occur and sensitiveness of the joint, together with restriction of movements, is present, rest is still more necessary, combined with fixation of the joint. Here also it is best to err on the side of safety. Permanent extension by weight and pulley, the grasp on the limb of the extension plaster being in its whole length, should be applied and continued unremittingly, the foot of the bed being raised for counter-extension. Restless children should be carefully watched, and, if necessary, a plaster-of-Paris bandage applied. This measure, however, is for the purpose inferior to the weight and pulley extension (Fig. 776). The amount of weight employed should be one pound for each year of the patient's life, up to twenty (Dawbarn). The employment of local medicaments, blistering, etc., is of little use, when they are applied to the surface. Senn speaks highly of the use of a 10 per cent solution of iodoform in sterilized glycerin thrown into the joint after evacuation of the contents of the synovial sac. This injection is made at a point where a line drawn from the spine of the pubis to the upper margin of the great trochanter crosses the inner margin of the sartorius muscle. The primary focus of infection, either in the femur or in the acetabulum, cannot be reached; iodoform is likewise useless after the parts have become infected with the microorganisms of pus infection. The method of Phelps, that of employing pure carbolic acid in suppurating joints, followed by alcohol, is a very promising one.

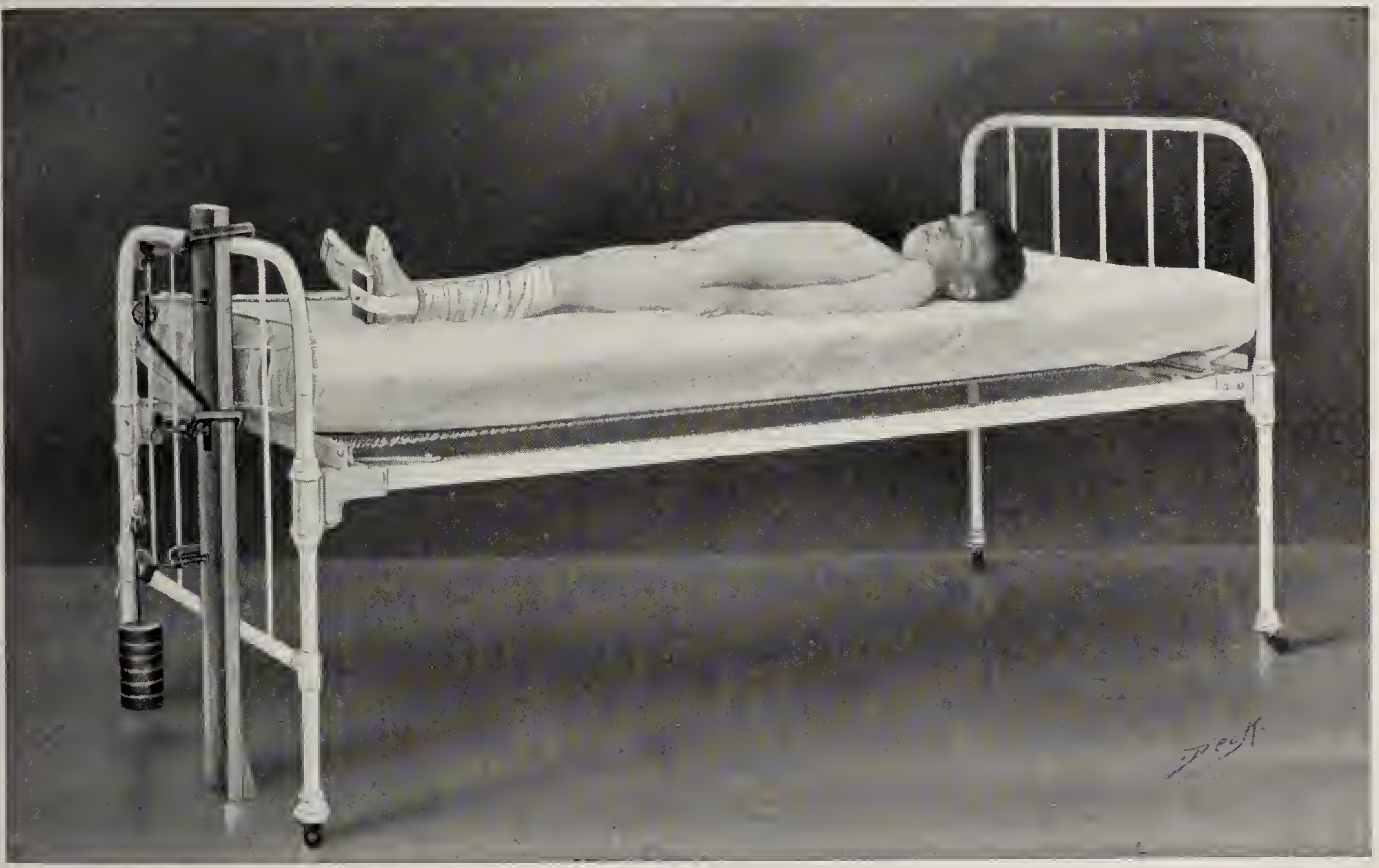

Fig. 776.—Weight and Pulley Extension.

In the presence of flexion and adduction of the femur or other malpositions of the limb, special measures must be taken to correct these in order that, on recovery, the child may be able to walk without deformity. It may be urged that the position of the limb is conservative and designed to relieve tension and alleviate pain; the position of the limb soon becomes an extreme one, however, and while tension on one portion of the capsule is relieved, it is increased in other portions. Experience shows likewise that correction of the perverted position, combined with traction, has a directly favorable influence on the inflammation. There are two methods of overcoming the deformity, namely, slow gradual traction in a line to correct this, or correction under an anesthetic, the limb being put up in plaster-of-Paris. The former is to be preferred and should be given a trial.

Experiments made by Morosoff demonstrated that from 40 to 50 pounds were required to effect a separation of half an inch in cadavers. The application of such a force would be impossible in the living subject. The immobilization of the joint produced is the effective agency in the cure, together with the effect of the traction in overcoming the spasm of the muscles. On the other hand, the changes which the joint undergoes in the course of the disease, namely, loosening or destruction of the capsule and more or less change in the shape of the head of the femur, make the conditions different from those existing in the cadavers on which Morosoff experimented. Lannelongue, by extension applied to the diseased limb, obtained two inches separation in the cadaver of a child who had suffered from hip-joint disease for five months and had died of croup.

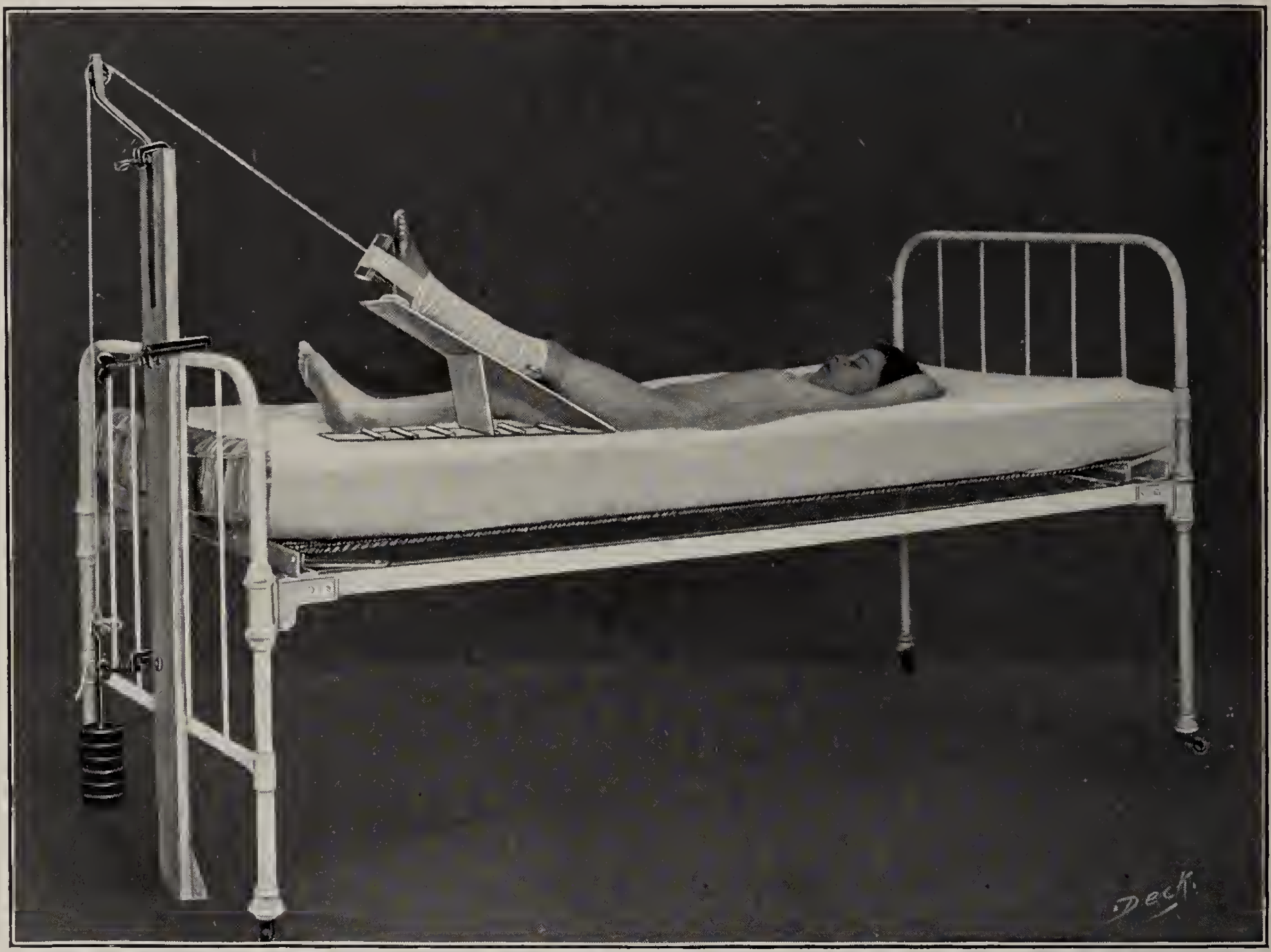

Fig. 777.—Combined Extension and Inclined Plane for Reduction of Contracture of the Hip.

To overcome the flexion of the femur it is often sufficient to make the extension with the limb resting on the level of the mattress, both the flexion and the lordosis disappearing with persistent traction. With a high degree of flexion, in which it is impossible to bring the limb to the horizontal, the extension is applied with the limb placed on an inclined plane; the latter is lowered from time to time until it is no longer needed (Fig. 777). The adduction frequently yields with the flexion. Should it not, extension may be applied to the other limb as well, the lines of traction being such as widely to separate the two limbs. It may be necessary to make counter-extension by a perineal band placed on the healthy side (Volkmann).

The above measures are successful in the great majority of cases in which the flexion can be reduced to less than a right angle by the production of a compensatory lordosis. In cases, however, in which the limb is flexed, say until the thigh rests against the anterior abdominal wall, the application of weights acting horizontally is impossible, and **partial correction** under general anesthesia is indicated, the limb being brought down sufficiently far for efficient traction to be made. Complete correction is not justifiable and may either result in inflicting grave damage on the joint or lead to a renewal of the inflammation. In case great resistance to correction is encountered and the limb tends to spring back to its former position, a plaster-of-Paris bandage may be applied.

Portative fixation apparatus should be applied as soon as the deformity is overcome and the pain abolished. The Davis, Bauer, Sayre, Taylor, and Shaffer apparatus have all had their advocates. The Taylor splint or brace is most frequently used, and fulfils the indications in a practical manner (Fig. 778). It is applied with extension strips of adhesive plaster extending from the upper part of the thigh to the malleoli. These are attached to the straps on the footpiece of the apparatus. The foot is prevented from touching the floor in walking by a thick sole placed on the shoe of the opposite foot. A rack-and-pinion mechanism regulates the length of the brace. The splint is supported above by a pelvic band, and, in walking, the patient bears the weight of the body on two perineal straps. In adjusting the brace the latter should be lengthened sufficiently to permit the foot to swing clear of the foot-piece when the patient bears the entire weight on the diseased side through the medium of the splint, the weight of the body being transferred to the brace through the perineal bands. Theoretically extension is made; practically, however, the traction is slight, but the fixation is most efficient.

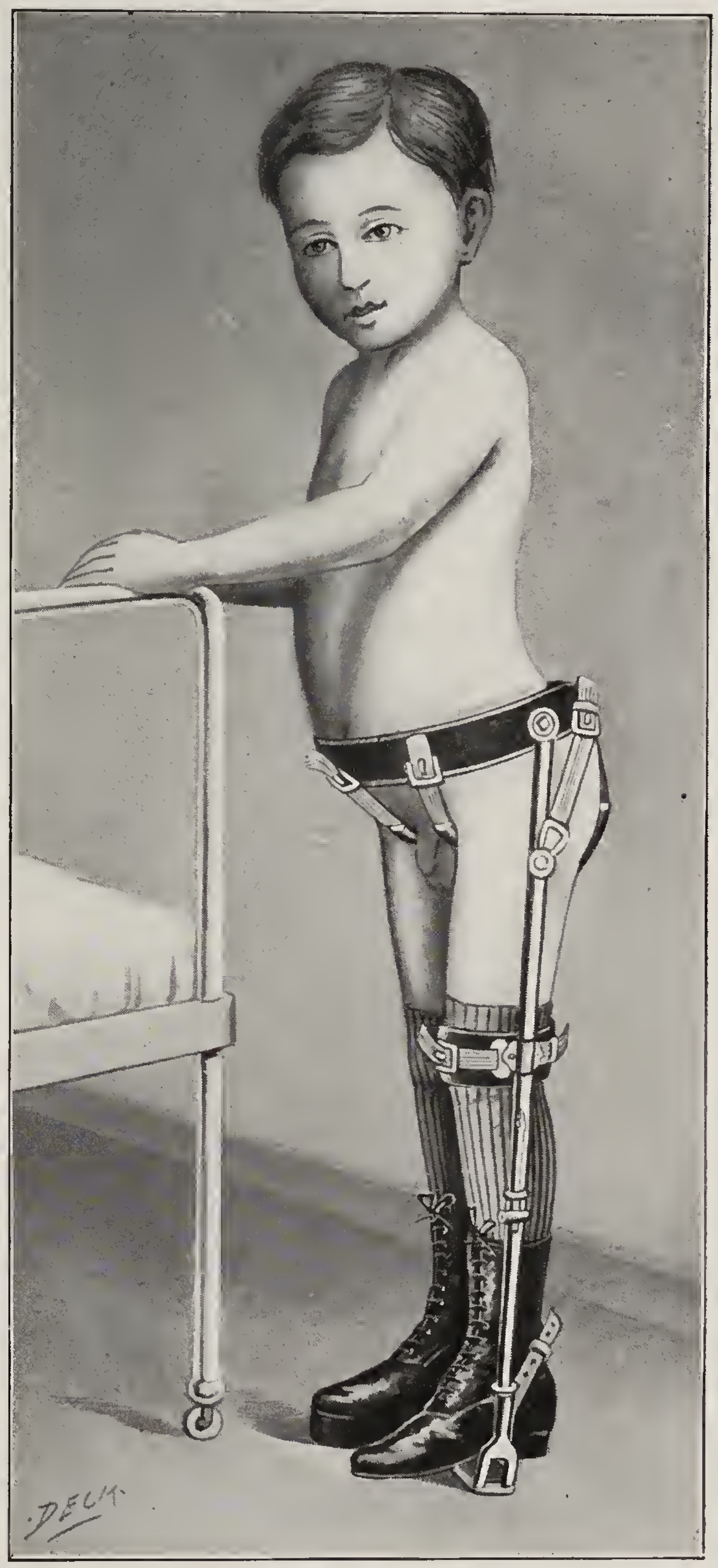

Fig. 788.—Taylor's Long Traction Splint Applied.

The weight and pulley extension should be kept up at night by means of a slipper, to which the cord of the weight may be attached. In cases in which the plaster causes irritation of the skin, a closely fitting rawhide bootlet made on a plaster model of the foot may be substituted for it. This is only a temporary expedient, however, since the knee-joint will suffer from too long traction made from the ankle alone.

Simple yet efficient forms of apparatus are those of Thomas (Fig. 779) and J. Wolff.

The Question of Early Resection.—Up to within the last decade, it was taught that resection of the hip was the only operative procedure indicated in the radical treatment of hip-joint disease, and that measures of drainage were of but slight, if any, benefit. Resection was formerly performed at the first appearance of suppuration, and even before. At the present time it is better for the surgeon to open the abscess freely and to carry pure carbolic acid thoroughly to all the deeper diseased parts, permitting it to remain in contact with the latter for about one minute. Ninety-five per cent alcohol is then applied, which prevents any untoward effect of the carbolic acid on the tissues. Should diseased bone be accessible at the time, this should be removed with the sharp spoon. If the acetabulum is diseased, it is better to resect at once, in order to accomplish efficient drainage. Should no diseased bone be

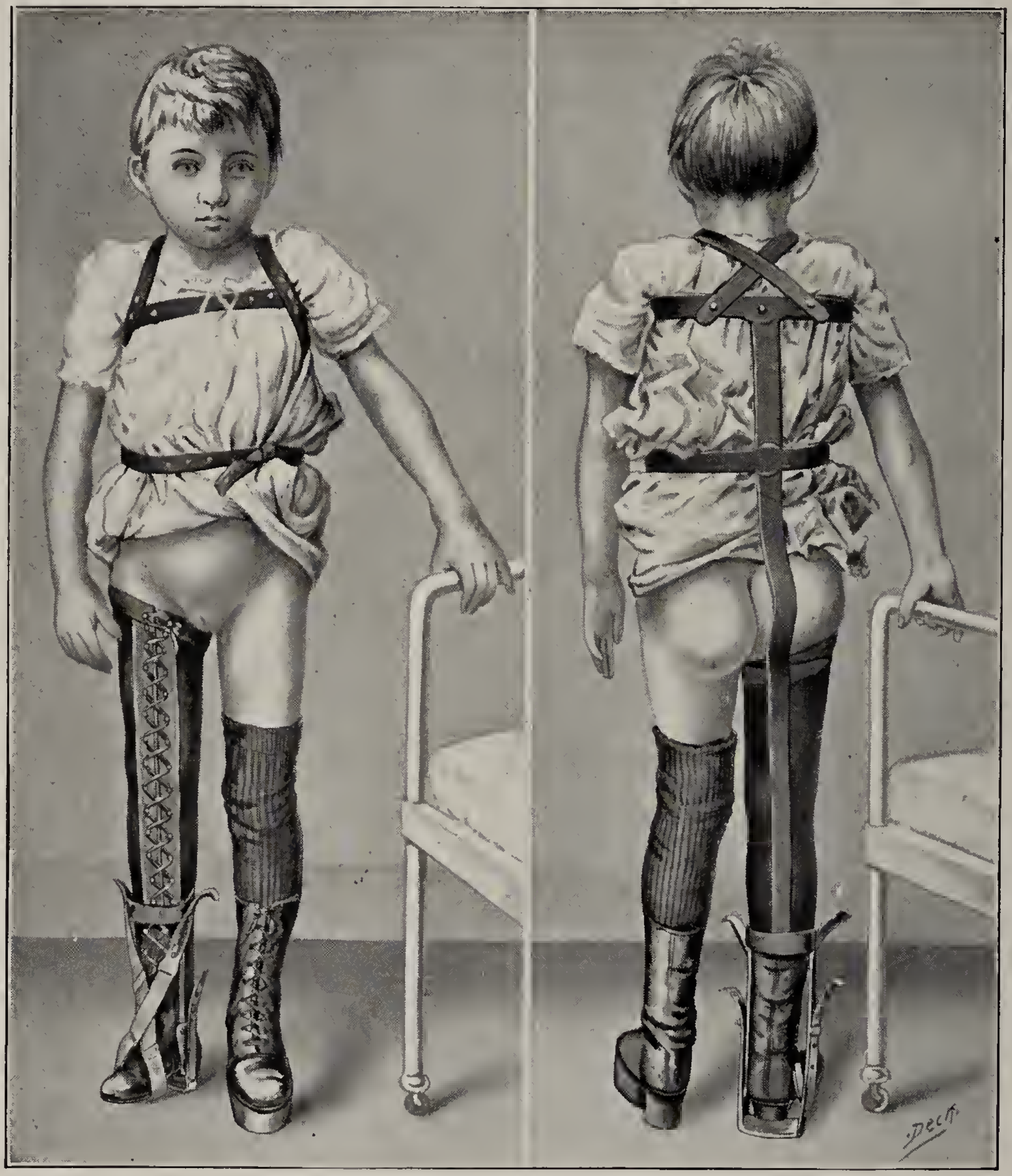

Fig. 779.—Thomas's Hip Splint Applied.
Anterior and posterior views.

found and yet suppuration persist, resection in this comparatively early stage is indicated; drainage is at the best but defective without it, and persistent suppuration after the above measures have been applied usually indicates acetabular disease, in which the mortality is high in spite of the most radical measures.

In the class of cases, fortunately rare, in which the early symptoms show an unusually virulent infection, with the rapid development of tuberculous synovitis and secondary parasynovitis, with persistently increasing tenderness and swelling in spite of extension and fixation, and fever, general tuberculous infection is to be feared. This can be avoided only by early resection, which should not be delayed.

Late Resection in Hip-joint Disease.—As long as the disease remains a local one, in the most advanced stages of the disease and even with abscesses diffused on the thigh, resection may still be performed, supplemented by incisions whenever needed. **Perforation and escape of pus through the softened base of the acetabulum into the lesser pelvis** are always an indication for resection. The occurrence of this complication is to be suspected in case of edematous and hard infiltration of the connective tissue of the pelvis, and sensitiveness as shown by palpation of the inner wall of the pelvis from above or from the rectum. Fistulous openings in the lower abdominal wall and in the perineum also indicate this complication. While resection does not promise much in this class of cases, yet it is the only hope, and should be resorted to. It must be supplemented by other drainage incisions when necessary.

Contraindications to Resection.—Resection is contraindicated in cases in which complications are present which in themselves are necessarily fatal, notably advanced **amyloid degeneration of the abdominal organs,** and **general tuberculosis.** Commencing amyloid degeneration may be still susceptible of arrest with the removal of the cause, but nothing can be expected in cases in which the spleen is enlarged with changes in the intestinal mucous membrane, as shown by chronic diarrhea. It is worse than useless to resect in cases in which diffuse bronchial catarrh, chronic capillary bronchitis, and high evening temperature which is not explained by the condition of the joint, give rise to a well-founded suspicion of commencing general tuberculosis. Even if the resection is successfully accomplished, the wound will refuse to heal.

The **mortality** of resection of the hip-joint amounts to over 50 per cent (Jacobson). While this seems high, it must be remembered that it is only in the most desperate cases that the operation is resorted to. On the other hand, the mortality in the same class of cases without operation is upward of 75 per cent.

Conditions Essential to Success.—The following are among the conditions essential to success in resection of the hip-joint: (1) **Age.** The most favorable age is from six to fourteen. After eighteen the operation should rarely be performed, amputation at the hip-joint taking its place (Jacobson). Some place the age limit somewhat earlier (Wright). (2) **Absence of amyloid degeneration.** Amputation is to be preferred in cases in which this condition is present, particularly in the kidneys or intestines. (3) **Absence of tuberculous disease of other parts,** *e. g.*, the joints or lungs. (4) **The complete removal of all diseased bone, as far as possible, and the removal**

or curetting of all sinus tracks. (5) Efficient drainage and careful asepsis in the after-treatment. (6) The prevention of deforming positions during the healing process. (7) Early upright position with some form of portative apparatus, or the use of crutches. (8) Fresh air and the administration of tonics and rich nourishing food.

Contractures of the Hip-joint and Their Treatment.—Contractures of the hip-joints are rare if we exclude those which arise in connection with hip-joint disease. These are **contractures due to psoas abscess,** to periarticular inflammations of different kinds, arising from the bursae mucosae, muscles, or connective tissue about the joint. These disappear in most instances with the removal of the cause, cicatricial shortening in the involved tissues rarely following. Paralytic and congenital contractures are very rare in this region.

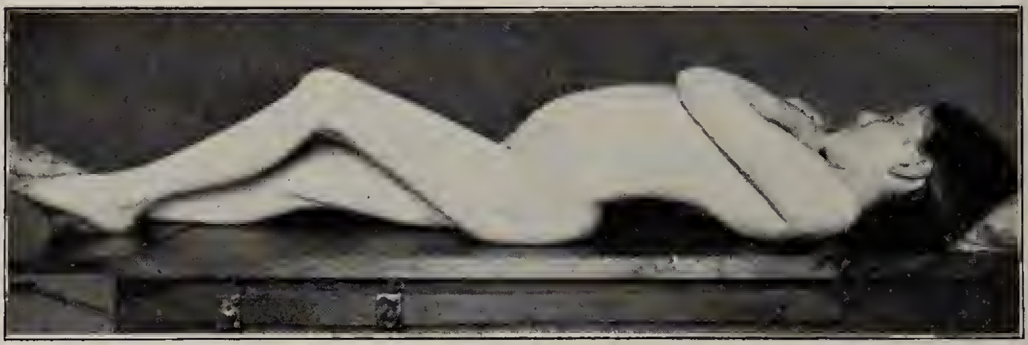

Fig. 780.—Faulty Ankylosis Following Hip-joint Disease.

For contractures due to hip-joint disease the preventive treatment already outlined is of the greatest importance. Delay in securing correction of these because of the intensity of the inflammation may occur in some cases; in every case, however, the treatment from the very commencement must be so directed as to secure a proper position of the limb in supporting the trunk, for the reason that, even under an anesthetic, contractures of the hip-joint are very difficult of correction. **Tenotomy** of the fascia lata, sartorius, etc., is useful in removing the obstruction to correction as far as the muscles are concerned, but this leaves the portion of the contracture due to articular and periarticular cicatricial bands yet to be overcome. The presence of the latter, as well as that of true ankylosis, will require that subtrochanteric osteotomy be performed (Figs. 780 and 781).

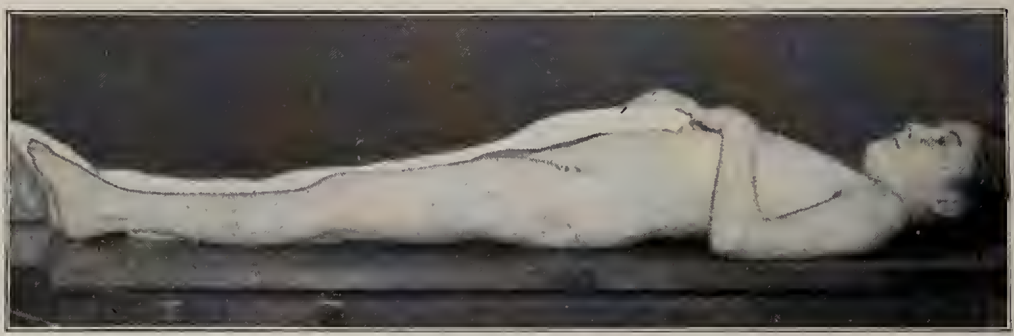

Fig. 781.—Position of Limb Following Subtrochanteric Osteotomy for Faulty Ankylosis from Hip-joint Disease.

In cases of a high degree of flexion at the hip-joint, there exists usually a **secondary contracture at the knee-joint.** The biceps, the semimembranosus, and the semitendinosus are shortened consequent on the patient's efforts to bring the foot to the ground in walking and to secure a support for its weight in lying. Correction of the flexion at the hip-joint will correct that of the knee to a certain extent, but it may be necessary to correct the latter by tenotomy at the same time.

Coxa Vara.—True coxa vara is a non-inflammatory, non-traumatic softening of the neck of the femur occurring in young individuals, either accompanied or followed by deformation. The latter consists in a bending downward of the neck of the femur until it reaches a horizontal line, the resulting deformity causing shortening of the limb. There is also a posterior curve to the femoral neck which causes outward rotation; rarely an anterior curve is present, in which case an inward rotation is observed. The structural pathologic changes are limited to the neck of the femur. The bending of the femoral neck is due to the weight of the body, and the torsion of the femur is caused by muscular action and ligamentous traction.

The **etiology** of the disease is obscure. By some it is regarded as a localized osteomalacia (Kocher, Lauenstein). It has also been attributed to changes in the architectural arrangement of the arches in the bone without previous softening, the neck giving way under the superimposed weight of the body (Whitman, Sudeck). By others it is considered as a form of arthritis deformans (**arthritis deformans coxae,** Charpentier, Kirmisson). Haedke examined a specimen removed by resection and found changes similar to rachitis. Finally, a trophoneurotic origin for the disease has been suggested (Senn).

The **symptoms** consist of pain in the hip-joint, radiating on the inner and anterior surfaces of the thigh to the knee, and more or less impairment of function of the joint. Pressure on the joint does not elicit tenderness. Constitutional disturbances, fever, etc., are absent. A slight limp is present. The general health of the patient is good. Examination in the upright position shows flattening of the gluteal region and depression of the gluteal fold. There is apparent shortening due to tilting of the pelvis. The trochanter is elevated above Nélaton's line. The actual shortening is proportionate to the obliquity of the femoral neck, and varies from half an inch to an inch and a half. There is adduction of the limb, due to diminution of the angle of the neck of the femur, and outward rotation from posterior curving of the femoral neck. Exceptionally, when the curve in the neck is placed anteriorly, the limb is rotated inward. In extreme cases of posterior curvature of the femoral neck the latter may be felt in front at the base of Scarpa's triangle. The only loss of function present is due to mechanic obstacles to the movements of the joint. Abduction and inward rotation are the movements most interfered with. Interference with complete extension gives rise to lordosis. The affection may be unilateral or bilateral. When unilateral, static scoliosis may be present.

The **diagnosis** rests on the occurrence of the affection in young adolescents, pain in the hip radiating in the direction of the knee-joint, and the presence of adduction and outward rotation of the femur. The comparatively rapid advance of these symptoms is characteristic of the disease. The affection is to be differentiated from tuberculous coxitis by its more abrupt onset, the absence of constitutional disturbance, fever, etc., the usual spontaneous cessation of the acute symptoms, the absence of muscular rigidity and of nocturnal twitchings, and of pain on slight movements of the thigh, and tenderness over the joint. Muscular atrophy is less marked in coxa vara than in tuberculous coxitis. In coxa vara the shortening occurs early in the case; in tuberculous coxitis this is a late manifestation. The Röntgen ray may be of service in the differentiation.

In traumatic or pathologic separation of an epiphysis (**epiphyseolysis**) a history of an injury is usually obtainable.

The **vital prognosis** is favorable. The disease is self-limited, and spontaneous recovery eventually takes place. The pain gradually disappears, and improvement is soon manifest. Restoration of the function of the joint depends on the degree of deformation of the femoral neck.

The **treatment** during the acute stage consists in rest in the dorsal recumbent position, and weight and pulley extension. On the subsidence of the pain the patient may be allowed to go about on crutches, wearing a thick-soled shoe on the sound side. At the termination of the acute stage, baths, massage, and electricity may be useful. The range of motion of the joint may be increased by forced motion under a general anesthetic. If the usefulness of the limb is not restored by these means, operative measures may be resorted to. Of these, subtrochanteric osteotomy (Hofmeister, Hoffa), subtrochanteric resection (Kocher), and intertrochanteric linear osteotomy (De Forest Willard) are the most applicable. Resection should be reserved as a last resort.

CONGENITAL DISLOCATION OF THE HIP-JOINT

This is relatively frequent among congenital dislocations. It should not be confounded with traumatic dislocation occurring during birth. The iliac dislocation is the form most frequently observed; according to Tillmanns, the head usually lies above the acetabulum, but as the result of walking the head moves backward on the dorsum of the ilium. These cases are to be considered essentially as of fetal malformation. The development of the dislocation is favored by sharp flexion and extreme adduction of the femurs in the fetus, particularly in the case of an abnormally small uterus (Dupuytren, Roser). Too early fusion of the three bones comprising the acetabulum has been assigned as a cause (Dollinger). Disturbance of equilibrium of the muscles arising from congenital affections of the central system with atrophy of one group, contraction of the remaining muscles predominating, and removing the head from the acetabulum, was believed by J. Guerin to be the cause. The paresis of single groups of muscles observed at the end of the first and the beginning of the second year probably arises secondarily. Tillmanns, in dissecting a case of congenital dislocation of the hip in a girl six months old, found an abnormal development of the ligamentum teres, which filled the articular cavity so completely that the head had not sufficient room in the shallow cavity. The malformation is more frequently observed in females (Adams). It is more frequently single than double (Boyer, Kirmisson and others). The occurrence of breech deliveries does not seem to have a marked influence (7 out of 45 cases).

Diagnosis and Treatment of Congenital Dislocations of the Hip-joint.—The gait of the patient is thoroughly characteristic. In cases of double dislocation, in consequence of an insufficient fixation of the head of the femur, the patient waddles like a duck. A tottering gait as the child begins to walk first attracts attention. **Lumbar lordosis** is present; the muscles passing from the pelvis to the thigh are shortened and the pelvis is inclined forward (Fig. 782). Extreme adduction of both thighs in those cases produces a **"scissor-legs" malformation** (Esmarch). In examining a case of congenital dislocation of the hip from behind, a characteristic projection is visible, which can be identified by rotation as the head of the femur. This is found to be above Nélaton's line even when lying down; the distance is increased when the patient stands erect. The glutei muscles are atrophied. This atrophy accounts in part at least for the waddling gait; these muscles are unable to hold the pelvis in a horizontal position, but allow it to slide over, first to one side and then to the other as the patient walks (Trendelenburg). The gluteal region is flattened in consequence of the atrophy, and also from the absence of the head of the bone in its normal location.

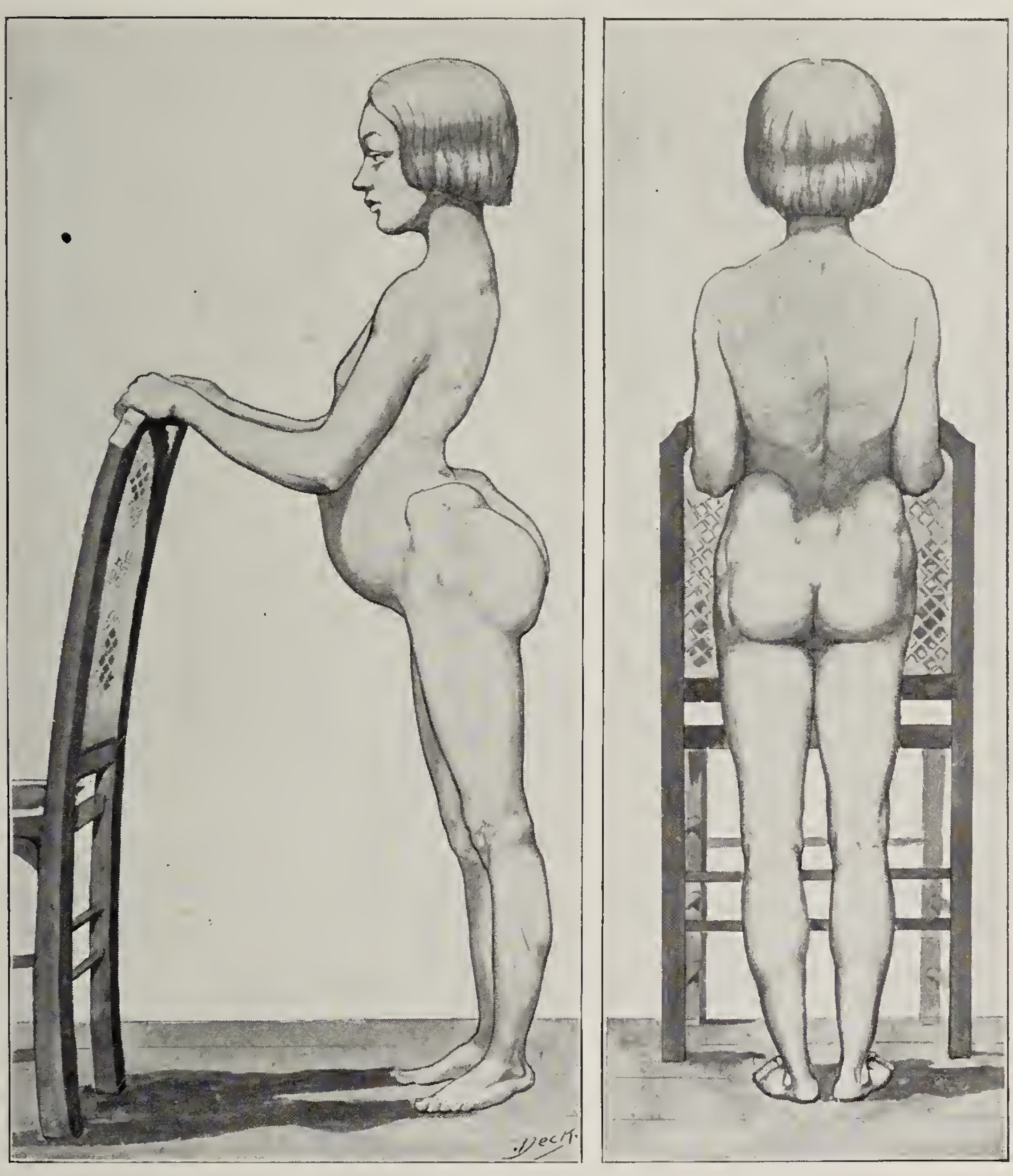

FIG. 782.—CONGENITAL DISLOCATION OF THE HIP-JOINT.

The **prognosis** is particularly unfavorable in older children. Even in younger children efforts at cure are only relatively successful. Success in avoiding further development of the affection is usually all that can be hoped for. In case of females, should the malformation progress, the development of the pelvis is interfered with, narrowing of the exit of the pelvis results and there is a consequent bar to natural delivery (Cruveilhier).

Treatment.—An effectual treatment, even for the arrest of the malformation, is usually very difficult. A jacket of felt with silicate of soda and shellac incorporated in it, made over a previously made plaster-of-Paris model, will improve the waddling gait (Fig. 783, Tillmanns). Schede and Mikulicz have also devised apparatus for this affection. Taylor's hip-joint brace has been used, but after a time impairment of movements at the knee-joint follows its use. In view of the fact that the head of the bone is larger than the socket, it is useless to attempt complete reduction by manipulation and extension.

Hoffa and Lorenz have each devised an operation for the radical cure of congenital dislocation of the hip-joint which has for its object the formation of a new acetabulum. After a periosteal flap is turned back, the joint is chiseled out. The head of the bone is then placed in the new hollowed-out socket. Langenbeck's posterior incision for resection of the hip is employed by Hoffa. Lorenz opens the joint in front by an incision which is carried directly downward from the anterior superior spine of the ilium and then inward at the level of the lesser trochanter. Hoffa frees the head of the bone subperiosteally from all muscular insertions at the greater and lesser trochanter, so that it can be drawn down into the region of the acetabulum. In Lorenz's operation the muscular insertions at the upper end of the femur are spared. Reduction of the head of the bone into the new socket is sometimes very difficult, owing to the shortening of the adductor muscles, and forcible extension has to be repeated several times. After reduction the wound is sutured, with a small opening left for gauze drainage; a plaster-of-Paris splint is applied and kept on for three or four weeks.

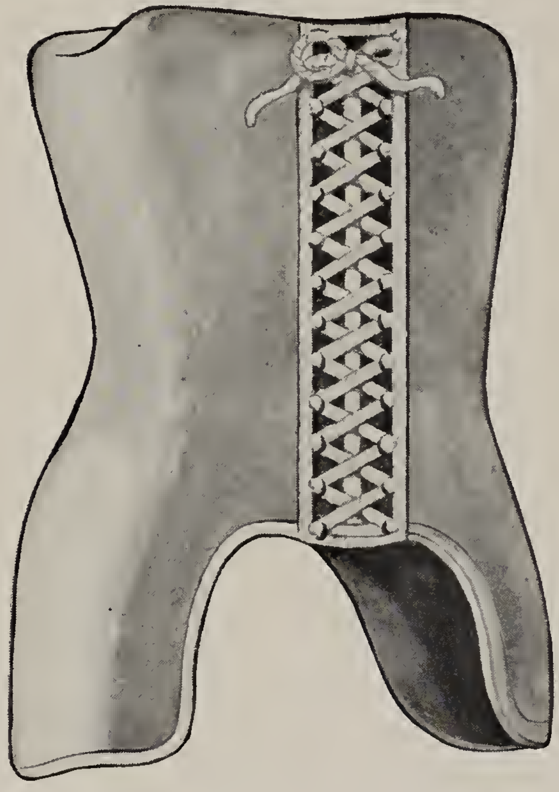
FIG. 783.—JACKET FOR CONGENITAL DISLOCATION OF THE HIP.

Lorenz has more recently employed a bloodless procedure, whereby the attempt is made forcibly to bring the head of the femur to a position as near as possible to the site of the normal acetabulum. All resisting structures are overstretched or torn by powerful manipulative efforts in order to effect this. The limb is then placed in a position in which the knee is flexed at a right angle with the thigh, the thigh at right angles with the abdomen, and the entire extremity is strongly abducted and rotated outward. The limb is maintained in this position for several weeks by means of a plaster-of-Paris bandage.

Inflammatory or Pathologic Spontaneous Dislocations of the Hip-joint.—The origin of inflammatory dislocations arising from hip-joint disease has already been referred to. The capsule is usually loosened or destroyed through the tuberculous process, and the acetabular defect produced in the same manner. The dislocation then follows very gradually; it is sometimes effected by a slight traumatism or muscular action, or by simply turning in bed.

Another and rarer kind of inflammatory dislocation is sometimes consequent on a rapid and large suppurative effusion into the joint in the course of typhoid fever, smallpox, measles, scarlet fever, diphtheria, puerperal fever, and pyemia (Güterbock). It may also occur in acute articular rheumatism (Verneuil). These cases of **distention dislocation** do certainly occur, the capsule being forced open and the head escaping by a small amount of pressure. In the great majority of cases, however, the dislocation takes place through destruction of the capsule (**destruction dislocation**). These dislocations occur in addition to those following tuberculous caries of the hip, in connection with the slipping forward of the fifth lumbar vertebra in cases of tuberculous destruction of the articulation, the so-called **spondylolisthesis.** Cases of spontaneous dislocation have been reported by Pitha in which no inflammation whatever existed, but in which the limb occupied for a long time a position favoring dislocation (**position dislocations**).

Inflammatory or **pathologic dislocations** usually occupy the position of either a sciatic or an iliac dislocation; all the symptoms of the corresponding traumatic dislocations are present.

A pathologic dislocation resulting from tuberculous disease of the hip-joint should always be remedied by resection. Dislocations resulting from typhoid and other infectious diseases may or may not require resection, and reduction may be attempted. Typhoid suppurations of joints, like those of pyemic and septicemic origin, are less dangerous, and sometimes undergo spontaneous resorption. If not, the joints may be incised. After reduction the limb should be put up in plaster-of-Paris to overcome the tendency to redislocation.

THE UPPER PORTION OF THE THIGH

Fracture of the Shaft of the Femur.—In civil life the majority of these fractures occur in the middle third of the bone. Gunshot injuries of the shaft of the femur may involve the important vessels and nerves in the neighborhood. Fracture of the shaft of the femur is quite rare in old age, being replaced in frequency by fracture of the neck.

The fracture may result from direct force, such as crushing by a heavy vehicle; or by indirect force, such as falls from a height, the patient striking on the feet. It rarely occurs from muscular action. The line of fracture is usually transverse in children, and in adults oblique from above downward and forward. Where a torsion force is applied, the fracture is very oblique.

Exclusive of gunshot injuries compound fracture of the femur is of comparatively infrequent occurrence, particularly in the middle and upper thirds, on account of the presence of the thick muscular structures of the thigh. When it does occur, the upper fragment usually perforates. This constitutes a particularly dangerous class of injuries on account of extensive suppurative complications in the large medullary canal and numerous muscular layers of the thigh.

Diagnosis.—Uncomplicated fracture of the thigh is usually easy of recognition. Though the thick overlying structures prevent accurate palpation, yet the deformity is generally marked and characteristic, this consisting of a bluntly angular outward bowing of the thigh. This is due to the direction of the force, which is usually from within outward; it is also favored by the normal curve of the bone. The action of the adductor magnus is of but minor importance in the production of the deformity. In fractures approaching the trochanter minor the short upper fragment is drawn forward and upward by the action of the iliopsoas muscle, the heavy extremity displacing the lower fragment in a backward direction.

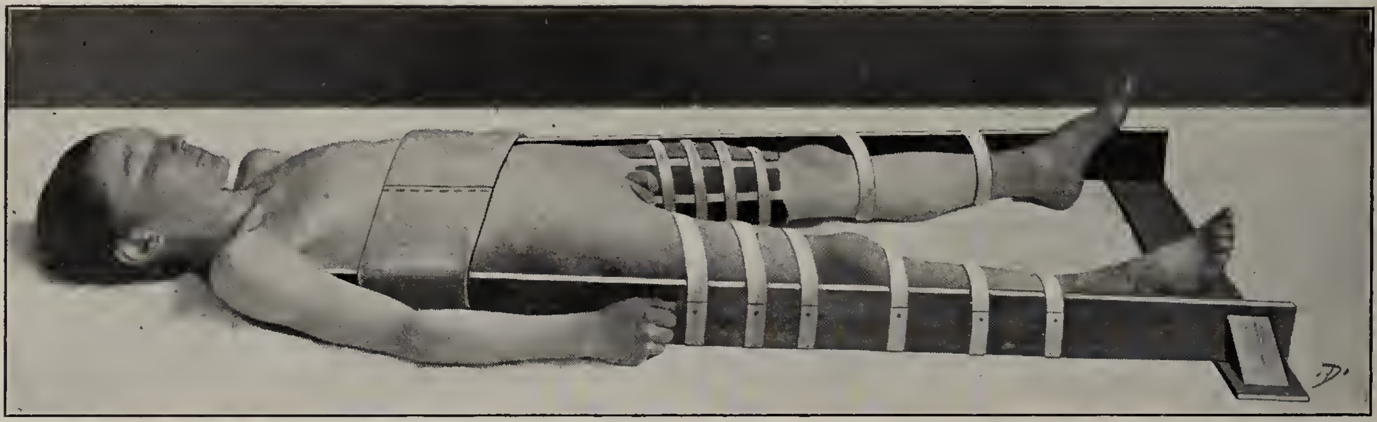

FIG. 784.—HAMILTON'S APPARATUS FOR TREATMENT OF FRACTURES OF THE THIGH IN CHILDREN.

Treatment.—Traction by weight and pulley extension to retain the fragments in position after reduction (Gurdon Buck) is the most satisfactory method of treatment. This may be supplemented by a long side splint with or without the railroad support (Fig. 767), the foot of the bed being raised for counter-extension. In order to prevent the patient from sinking in the bed,

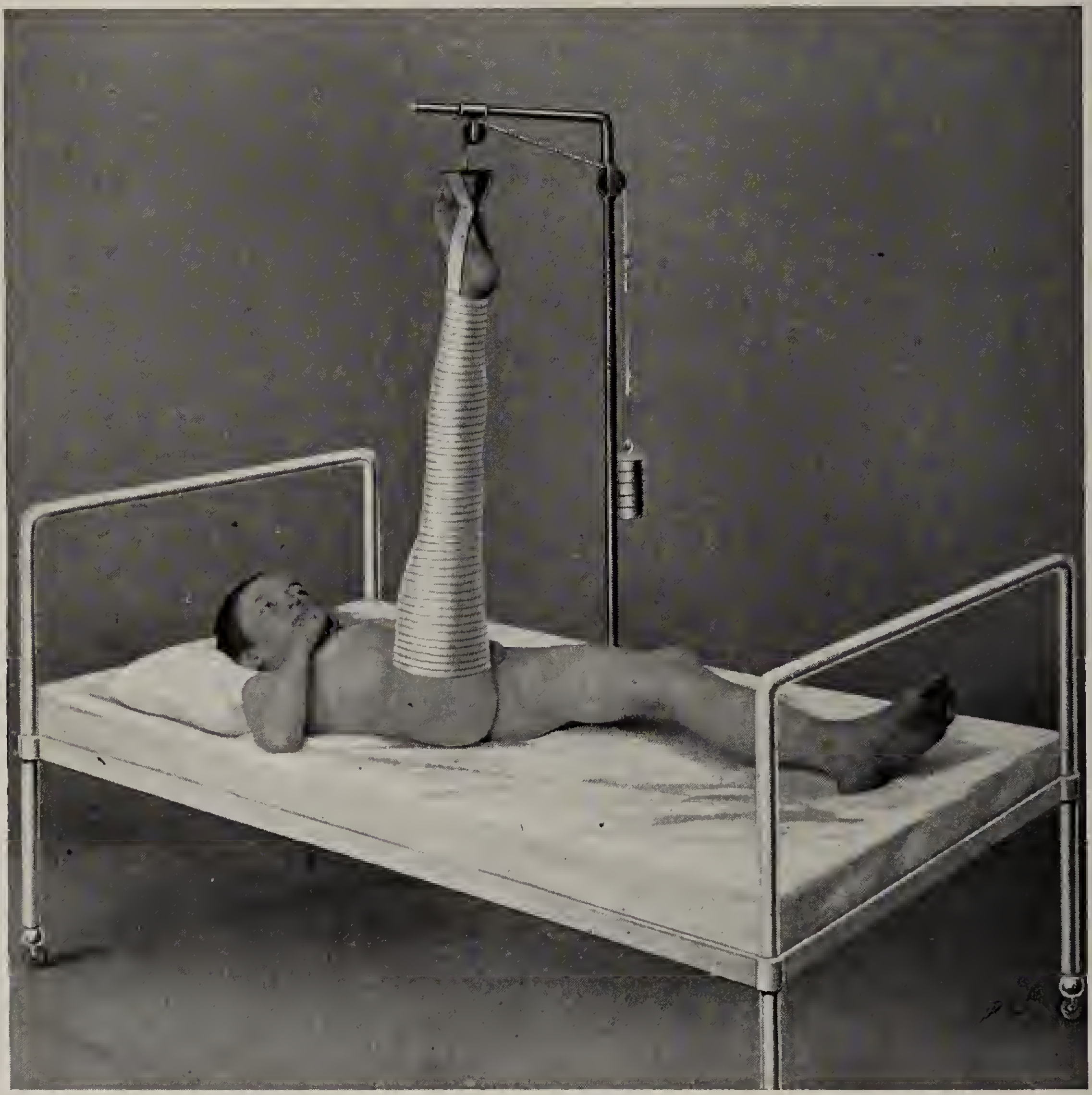

FIG. 785.—VERTICAL EXTENSION FOR FRACTURE OF THE THIGH IN CHILDREN.

a number of pine boards fastened together, of the length of the mattress, should be placed beneath the latter. Repair takes place more rapidly with this method than with the plaster-of-Paris fixation apparatus on account of the fact that the fixation is not so absolute, hence there is more or less constant irritation about the ends of the fragments, which favors formation of callus. Firmly applied circular bandaging likewise interferes somewhat with the blood-supply to the parts. Adults will require from 16 to 18 pounds. The head of the metatarsal bone of the great toe, the inner edge of the patella, and the anterior superior spine of the ilium should be kept in perfect alignment.

In children excellent results are obtained by the use of the double side splint (Hamilton, Fig. 784). The opposite limb and the rest of the body here act as a counter-extending force. The child may be removed from the bed when necessary. The method of suspension of the broken femur by vertical extension (Schede, Lentze) is well borne by the little patient, and possesses the advantage of enabling the nurse easily to keep the parts free from urine and feces (Fig. 785). Fracture of the thigh in new-born children occurring during labor is best treated by immediately flexing the thigh on the abdomen and there securing it by means of flannel bandages, supplemented by a light plaster-of-Paris bandage (Fig. 786).

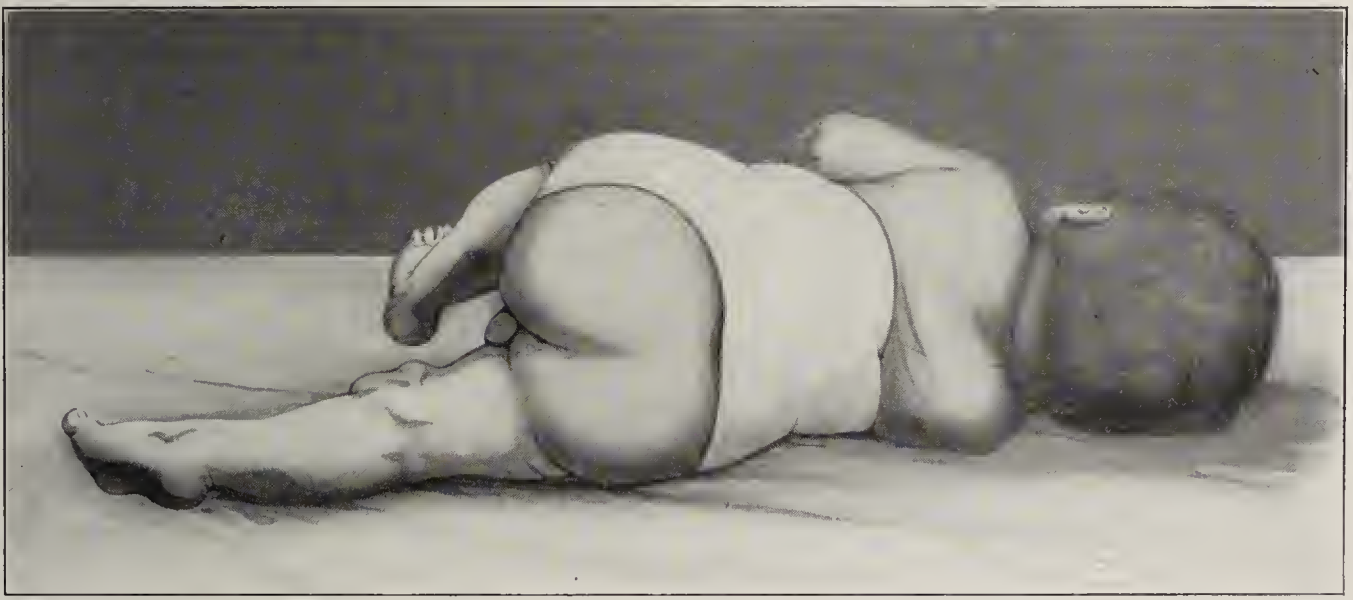

Fig. 786.—Plaster-of-Paris Bandage for Fracture of the Thigh in Infants. Posterior View.

Injuries of the Femoral Artery.—Owing to its situation the femoral artery is exposed to frequent injury. The majority of these injuries result from stab and gunshot wounds. Provisional control of the bleeding is quite easily accomplished by direct pressure, the vessel being forced against the femur.

Ligation of the Femoral Artery.—The point of election for the ligation of this vessel is at the apex of Scarpa's space, below the point of origin of the profunda. The general course of the vessel in this situation is represented by a line drawn from the anterior superior spinous process of the ilium to the adductor tubercle on the inner condyle of the femur. It is exposed by a three-inch incision commencing three inches below Poupart's ligament. The sartorius muscle is exposed and identified by the direction of its fibers, and retracted outward. The vessel is located in the wound by its pulsation as felt by the finger, and its sheath opened by a three-eighths inch incision on its outer aspect, the crural branch of the genitocrural nerve being avoided. The aneurism needle is passed from within outward, care being taken not to injure or include the femoral vein, which lies behind the artery at this point.

The limb is to be bandaged with cotton wadding and flannel, kept elevated, and artificial heat applied after the operation to avoid gangrene.

Wounds of the femoral vein possess a special importance other than that of the loss of blood, on account of gangrene of the extremity which may follow the necessary ligation. Lateral ligation, or suture of the vein, should be practised whenever possible.

Simultaneous injury of the femoral artery and vein may follow a stab wound of the thigh. The hemorrhage is usually arrested by pressure, and this provisional arrest of the bleeding may prove to be definite. In the course of time, however, owing to a persistent communication between the vessels (**arterio-venous aneurism**), disturbances of circulation in the limb occur, the latter becomes edematous and swollen, and a purring thrill, audible by the aid of the stethoscope for a considerable distance from the seat of the original injury, is present. The treatment consists in ligation of the artery above and below the point of communication.*

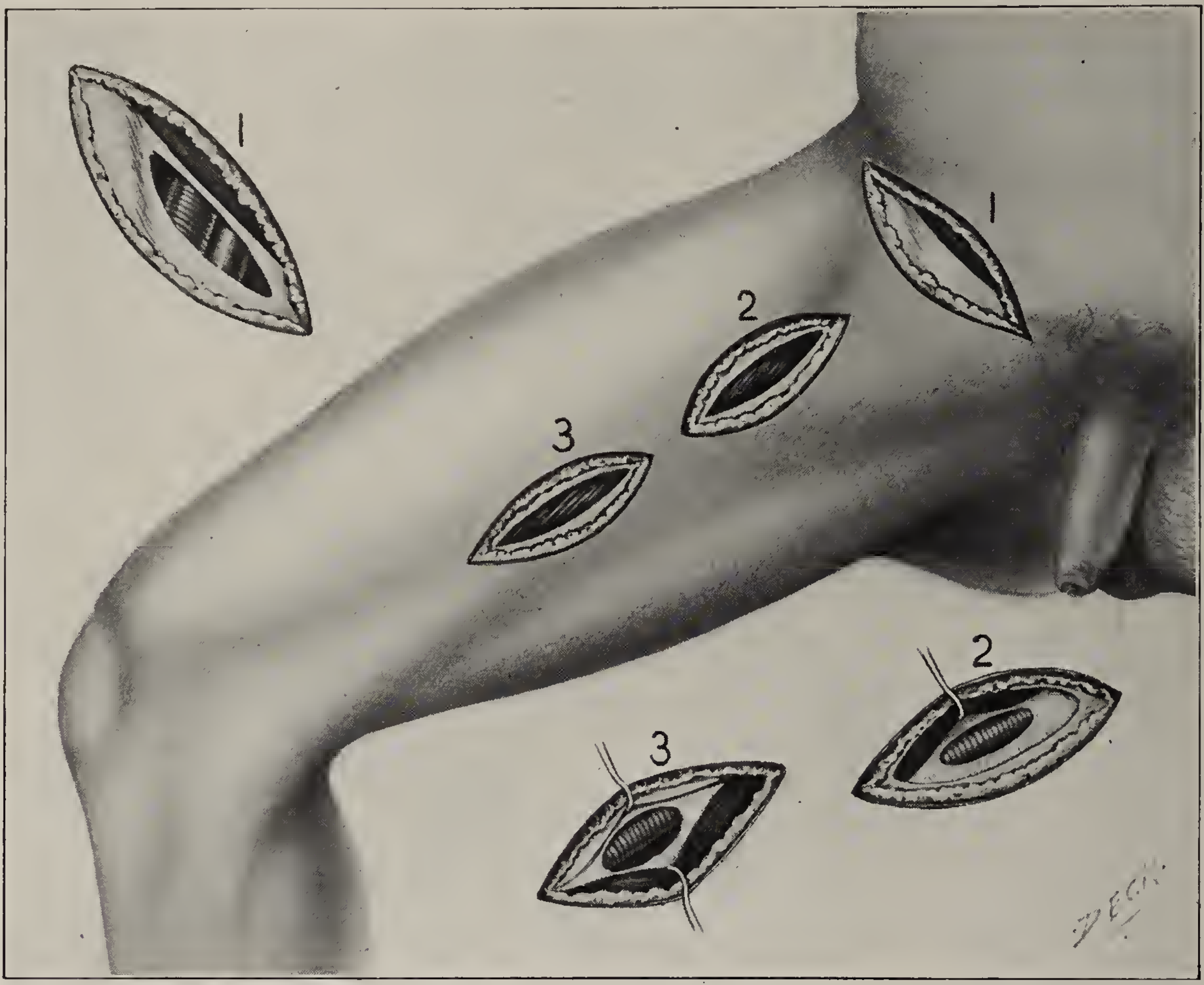

Fig. 787.—Ligation of the Femoral Artery.
1, In Scarpa's triangle; 2, above Hunter's canal; 3, in middle of thigh.

The Tumors and Lymphatic Glandular Swellings in the Region of the Hip and Upper Portion of the Thigh.—**Deep lipomas** occur beneath the gluteus maximus. They arise in the adipose tissue and sometimes extend through the sciatic notch and into the lesser pelvis. The internal portion is drawn out without difficulty during the excision.

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* In a case coming under my care at the Brooklyn Hospital this was done, but, with the establishment of the collateral circulation, a small branch communicating with the profunda, which came off from the femoral between the points of ligation, and which was unnoticed at the time of the operation, increased to such a size as to lead finally to a recurrence of the symptoms. Both artery and vein were resected at the point of communication at a second operation, after which the patient completely recovered.

Lymphatic Glandular Swellings.—The lymph-vessels from the genitals and from the entire lower extremity empty into these lymph-glands. **Septic lymphadenitis** is also found here. Here are also found the **buboes accompanying soft chancre,** as well as those of true **syphilitic** origin. **Tuberculous lymphadenitis** and the collection of cheesy lymph-glands known as **tuberculous lymphoma,** so often observed in the neck, are seldom found in the inguinal region. Secondary foci of infection from tuberculous disease of the hip-joint and knee-joint, and more rarely from similar disease of the ankle-joint, are found here. If they do not disappear after removal of the primary focus of infection, they may be removed.

Leukemic lymphomas in the groin are characterized by the same symptoms as leukemic lymphomas in the cervical region. **Sarcomatous lymphomas** are very rare; they are sometimes observed in metastases in sarcoma of adjacent parts. **Carcinomatous lymphomas** as secondary infection follow carcinomas of the penis, scrotum, vulva, and the rare epithelial carcinomas of the leg.

Lymphangiomas, as well as **varices of the saphenous vein** and **cavernous angiomas,** have been observed in the region of the vein. In all tumors of this region the possibility of femoral hernia in this region should not be lost sight of.

Sarcomas are more common in this region than in any other portion of the body. They usually spring from the muscles. They most frequently make their appearance between the thirtieth and the fiftieth year, and are more common in women than in men. They are characterized by rapid growth, early penetration of the fascia lata, and appearance under the skin. These tumors, appearing in this region, are usually inoperable. **Interilio-abdominal amputation** and **interilio-abdominal disarticulation** (Billroth, 1891; Jaboulay, 1894) may hold out some hope in the future for these desperate cases (see page 547). Of the nineteen patients operated on up to the present time, five survived the operation (Keen and DaCosta).

Aneurism of the femoral and profunda arteries has its origin almost exclusively in injury. Aneurism from endarteritis in this region is rare. Care must be taken not to mistake the aneurism for an abscess.

Primary sarcoma of the shaft of the femur is very much rarer at the upper than at the lower end of the femur. The disease can be removed only by amputation at the hip-joint.

Hydatid tumors of the soft parts of the thigh, particularly in the region of the adductors (König), as well as of the medullary cavity of the bone, have been observed (Reczey).

Resection of the Hip=joint.—The anterior longitudinal incisions (Lücke, Schede, Hueter) have the advantage of inflicting less injury on the muscles and the blood-supply, but they do not give such good access as the posterior incisions. Lücke and Schede make the incision along the inner border of the sartorius. Hueter's incision commences in the center of a line drawn from the anterior superior spinous process of the ilium to the point of the trochanter major, and extends along the outer border of the sartorius muscle (Fig. 788, A). It passes between the sartorius on one side of the fascia lata and the gluteus medius on the other, and meets the fibers of the vastus externus at its attachment at the anterior surface of the trochanter major and base of the neck of the femur. These fibers must be separated by the knife; they are the only muscular structures cut throughout the operation. The neck of the femur is isolated by blunt dissection, care being taken to avoid injury to the anterior circumflex artery. The capsule is now opened and the bone is divided with the chisel or saw from above and from the outer side in a downward and inward direction. For simple removal of the head of the femur, the incisions of Lücke and Schede suffice (Fig. 788, B); if the trochanter is to be removed the operation of Hueter is to be preferred.

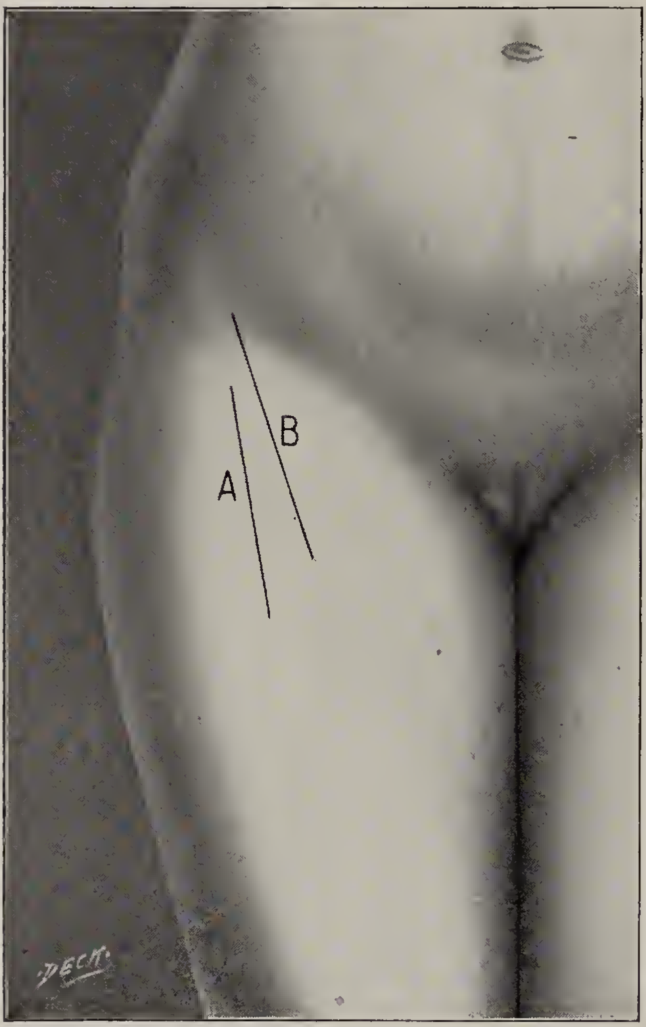

Fig. 788.—Lines of Incision for Resection of the Hip.
A, Hueter's incision; B, Lücke and Schede's incision.

The incisions of Langenbeck and Ollier are employed for the **posterior method.** In Langenbeck's operation (Fig. 789) the patient lies on the sound side with the affected limb flexed. The incision is made in the line of the femur from a point two inches above the top of the trochanter to three inches below it. The muscles attached to the great trochanter are freely divided as close to the bone as possible. The capsule is opened, if this has not already been done, and the finger introduced. If the disease is very extensive, the bone is divided by the Gigli-Haertel wire saw; if possible, between the trochanters. The upper fragment is then seized by forceps and removed, its remaining attachments, chiefly along its anterior border, being severed. The region of the acetabulum is easily reached through this incision, and diseased bone is removed if present. Tiling commences Langenbeck's incision farther forward on the anterior border of the trochanter, and then proceeds in a manner similar to that employed in Ollier's operation. Sayre employed a curved incision, embracing the trochanter major in the general direction of Langenbeck's incision. Ollier partly encircles the trochanter by a curved incision in such a manner that the upper end of the incision is about an inch in front of a longitudinal line drawn through the apex of the trochanter, while its lower extremity is the same distance behind the same line. The great trochanter may be sawed off while still attached to the muscles, and preserved if not diseased. The head and neck of the femur are well exposed in this incision for whatever further steps may be necessary. On completion of the operation the sawed off portion of the trochanter is replaced with its attached muscles. The posterior incisions give a better view of the parts and offer besides better drainage facilities, a point which will be seen to have an important bearing in the after-treatment.

The amount of bone to be removed in the operation will depend on the extent of the disease. As a rule, resection below the trochanter is indicated in late resection for tuberculous disease. In early resection simple decapitation may suffice.

The wound should not be sutured. The parts are to be swabbed thoroughly with pure carbolic acid, which after a minute's contact is to be neutralized with 95 per cent alcohol, and the cavity packed with gauze saturated with hydrogen peroxid solution. This is to be replaced afterward with Peruvian balsam dressings (Sayre), equal parts of Peruvian balsam and castor oil (Van Arsdale), or one part of ichthyol, two parts of Peruvian balsam, and three parts of castor oil. A good antituberculous mixture consists of equal parts of hydronaphthol and camphor rubbed up together in a heated mortar, to which is added a sufficient quantity of Peruvian balsam to equal the amount of syrupy liquid formed. To this mixture is added iodoform to the extent of 10 per cent. The wound is to be covered with sterile gauze, and the whole corresponding side of the pelvis is well wrapped with an abundant supply of gauze, covered with non-absorbent cotton.

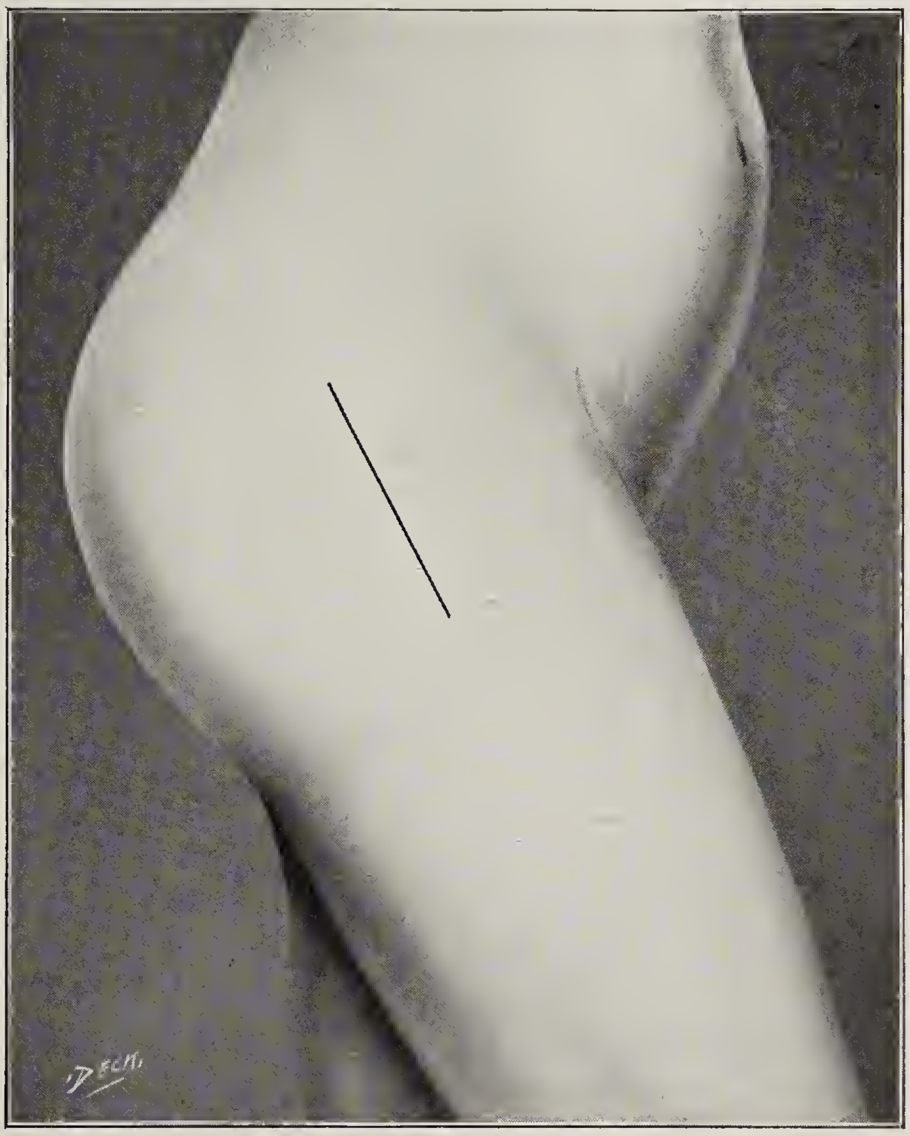

FIG. 789.—LANGENBECK'S INCISION FOR RESECTION OF THE HIP.

The After-treatment and Functional Results.—In the after-treatment extension and abduction must be made and continued for some time, particularly in children. The discharge is considerable for the first few days. To facilitate dressing of the parts without producing pain, to enable the nurse to prevent fecal matter and urine from soiling the dressings, and to relieve pressure on the sacrum and prevent the development of bed-sores, the limbs should be placed in the position of vertical suspension sometimes employed in fracture of the femur in children, with the limbs abducted, and the sacrum just free from the surface of the bed. This position also greatly facilitates the changing of the dressings, the pelvis being elevated during this procedure by shortening the cord connecting the foot-piece to the cross-bar of the apparatus (Fig. 790). When the discharge is less and the patient can be moved without great pain, extension in the horizontal position with abduction is to be made. Later on, during the period of simple cicatrization, Taylor's hip splint should be worn in the daytime and the patient encouraged to walk. Extension by weight and pulley is to be kept up at night. Fistulous openings which lead to tracks lined with tuberculous granulations should be frequently curetted, treated with pure carbolic acid and alcohol, and packed with gauze saturated with one of the above mentioned antituberculous medicaments. These will finally heal under this treatment if all the diseased bone has been removed at the operation.

The Functional Results of Resection of the Hip.—These are now conceded, and the value of the operation is no longer doubted. In some instances a reorganization of the joint takes place. In others, the lesser trochanter, covered with cartilage, has been found resting in the acetabulum, thereby forming a substitute for the head. There can be no question that resection gives a better limb than the average result obtained without operation in the class of cases in which resection is indicated according to the rules here laid down. If the operation is performed before it is positively indicated, it may be performed unnecessarily; the functional results following cure by orthopedic methods would certainly be better as regards the shortening and the supporting strength of the limb. On the other hand, in those cases in which the indications for resection are present, the longer it is delayed the greater the mortality, the more pronounced the flail-like character of the limb, and the greater the amount of shortening. When the latter conditions are present to the extent of a

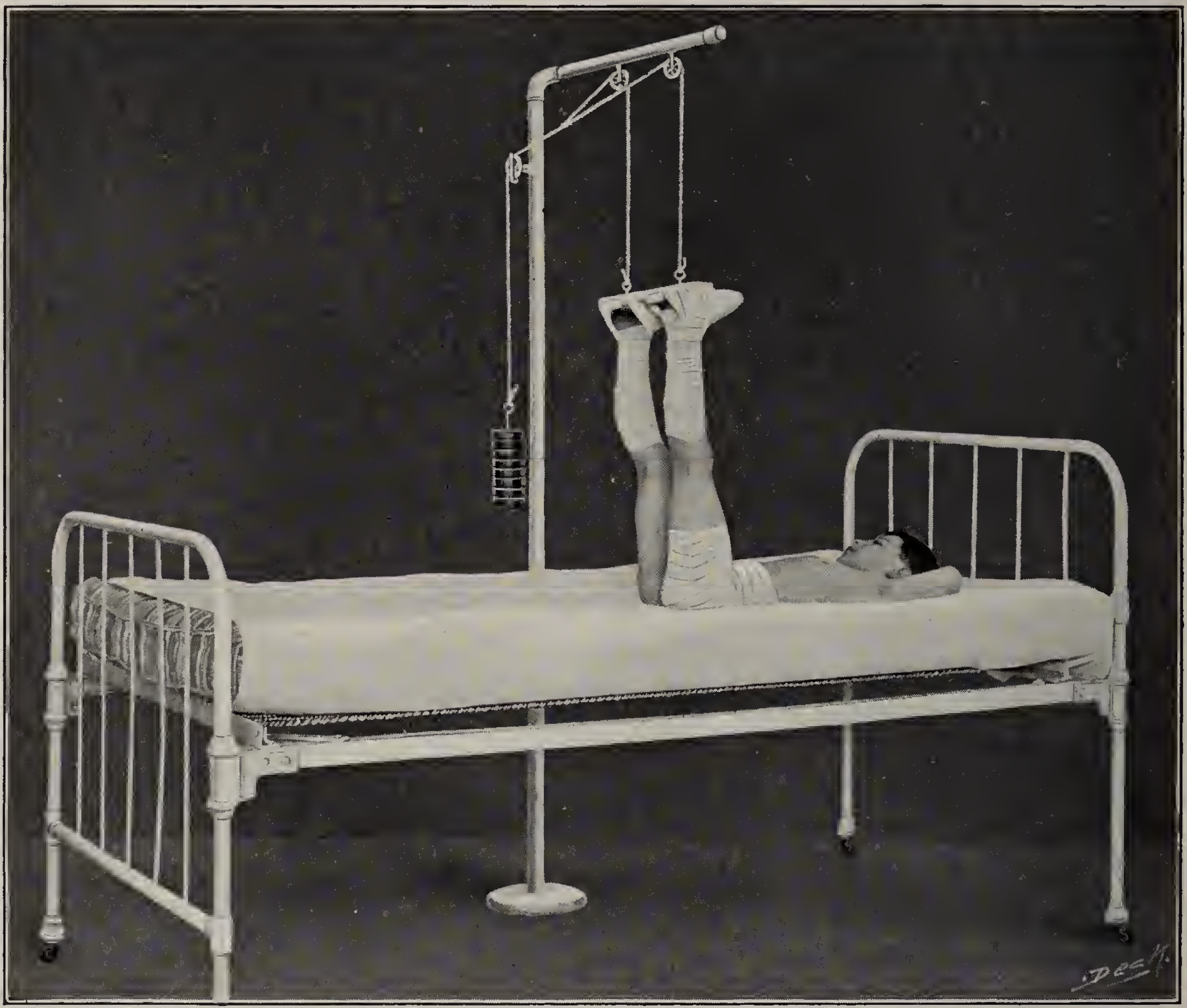

Fig. 790.—Vertical Extension in the After-treatment of Resection of the Hip-joint in Children.

comparatively useless limb, the result is to be attributed to the ravages of the disease which required such an extensive removal of bone, and not to the operation.

Operative Treatment of Contractures and Ankylosis of the Hip.—Forcible correction (**brisement forcé**) for these conditions may be first carefully attempted under an anesthetic. There is danger, however, of producing a fracture of the neck of the femur, or of lighting up a new inflammatory process. It should never be attempted while fistulas are still present.

The operations devised for the correction of these deformities are as follows: (1) **Subcutaneous** or **open division of the tense soft parts.** This may include the fascia lata, the iliopsoas muscle, and the adductors. These structures may be divided subcutaneously or the skin, contracted fascia, and, if necessary, the muscles may be divided by a V-shaped incision on the anterior and outer aspect of the thigh, the base being at Poupart's ligament. With the deformity overcome, the wound is closed by sutures so as to make a Y-shaped line of union (Winiwarter). (2) **Intertrochanteric osteotomy** may be performed if division of the soft parts fails. (3) **Section of the neck of the femur** (Rhea Barton) made through Sayre's or Ollier's posterior curved incision for resection of the hip-joint. (4) **Subcutaneous osteotomy of the neck of the femur** (Adams). (5) **Subtrochanteric osteotomy** (Volkmann). (6) **Cuneiform osteotomy** (*a*) in the neck of the femur (Rodgers); (*b*) below the trochanter. These latter are useful operations and are made through any of the incisions for resection of the hip-joint. (7) **Resection of the hip-joint.** Lauenstein operated in a case of contracture of the adductor of central origin by division of the obturator nerve beneath the fascia of the obturator externus muscle through a longitudinal incision extending from the spine of the pubis down to the anterior surface of the thigh. The deep dissection included division of the fascia lata, exposure of the outer border of the adductor longus, separation of the fibers of the pectineus, and finally incision of the thin fascia of the obturator internus.

Choice of Procedure.—If the case is an old one and there is rigid contracture of the soft parts with extreme flexion, they should be incised after Winiwarter's method. Should this not succeed, the femur may be reached and divided through the intertrochanteric line. Unless the soft parts are exceedingly rigid, however, it is best to leave these undisturbed in front, since the facilities for drainage are not so good at this point, and to employ one of the forms of osteotomy through a posterior incision. If bony bridges (Gant) span the space formerly occupied by the destroyed head and neck of the femur, an osteotomy below the trochanter is indicated; if, however, the neck can be identified, simple section of this will often suffice. If a subtrochanteric osteotomy will suffice, this may be a simple linear one; otherwise a cuneiform osteotomy may be performed after the soft parts, including the periosteum, are pushed to one side for about two-thirds of the circumference of the bone, and a wedge-shaped piece of bone corresponding to the flexion and adduction contracture is chiseled out, at as high a point as possible, with gouge and chisel. If the case is a comparatively recent one in which the muscular structures have been well preserved, and particularly if there is some inflammation present, the portion of bone above the line of section should be removed by gouge and chisel, the subtrochanteric osteotomy being thus converted into a resection of the head of the femur (Volkmann). Old ankylosis, however, with atrophic muscles and numerous cicatrices attached to the bone, are best treated by simple or cuneiform osteotomy.

The After-treatment.—An extension apparatus and a heavy weight, with the thigh in abduction, is to be applied after all of these operations, and its use continued until healing takes place. After recovery, to prevent recurrence, the patient should use the weight and pulley extension at night by means of a garter, laced well up on the limb.

Amputation at the Hip.—The former high mortality was 70 per cent in 486 cases (Aug. Lüning, 1877). This included both the traumatic and the nontraumatic cases. Of 239 cases in military practice, there was a mortality of 88 per cent, and in 153 nontraumatic cases the mortality was 42 per cent (Lossen). Ashhurst gives 64 per cent in 633 cases. These statistics were collected in preaseptic days for the most part, and before the present efficient methods were in use. Most of the patients died from hemorrhage; a large proportion likewise were lost from sepsis.

The operation is indicated (1) in **severe injuries of the thigh** which do not admit of conservative treatment and extend too high to permit amputation below the joint; (2) in **sarcoma in any portion of the femur;** (3) in **painful stumps after amputation of the thigh;** (4) in **tuberculous osteomyelitis of the shaft of the femur in connection with hip-joint disease,** and in cases where the acetabulum involvement is such as to prevent drainage after resection; also in advanced hip-joint disease, particularly in patients over eighteen years old, with amyloid degeneration of the kidneys and intestines when further delay in relieving the patient of the cause of the latter (the prolonged suppuration) will prove fatal.

The following **operative procedures** are available. Above all things, the circulation in the limb must be under absolute control by the employment of **prophylactic hemostasis.** Various abdominal tourniquets have been suggested for the purpose, but they have all been discarded. Macewen's method of compression of the aorta by the fist of an assistant is open to the same objections as the method by the abdominal tourniquet, namely, that it cuts off the circulation from a large portion of the body, and in addition entails some risk of possible injury to the abdominal organs. Preliminary ligation of the femoral vessels does not render the limb sufficiently bloodless. McBurney's method of compressing the iliac artery through an abdominal incision adds additional risks to the operation from septic peritonitis, and is not adapted to emergency conditions. The most trustworthy means at our command of controlling the hemorrhage is **elastic constriction** of the base of the flaps as high as possible above the lines of incision. The constriction is to be made by means of stout rubber tubing. On account of the shape of the thigh, some measure must be employed to prevent the constricting tube from slipping. This may be accomplished by the following: (1) By **Trendelenburg's rod,** which is thrust through the thigh from a point as high as possible on its lateroposterior border, passing in front of the hip-joint and emerging close to the perineum. Elastic tubing is passed in repeated turns beneath the rod and across the front of the thigh, constricting the vessels in its course. This method does not shut off the blood in the posterior portion of the flaps. (2) **Wyeth's pins.**

The outer pin is inserted one and a half inches below the anterior superior spinous process of the ilium, and a little internal to it, and emerges just behind the trochanter. The inner pin is entered one inch below the level of the groin, internal to the saphenous opening, and comes out an inch and a half in front of the tuberosity of the ischium. The elastic tubing is wound tightly around the soft parts above the pins and secured by a knot in front over the vessels. (3) Senn's method of preliminary dislocation of the head and isolation of the upper portion of the femur from attached soft tissues through an external straight incision, followed by the passage of a doubled length of tubing through the thigh from side to side, one of the lengths of tubing being tied about one

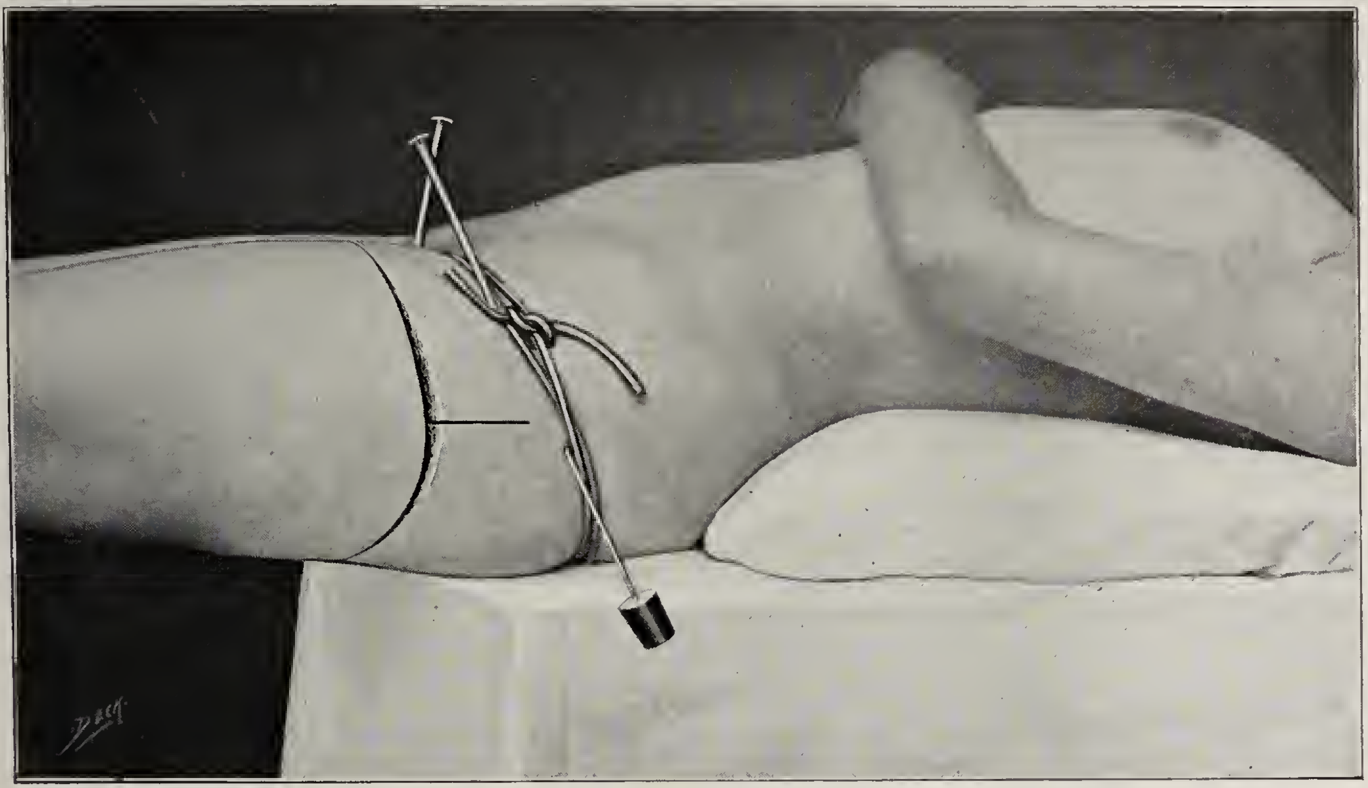

Fig. 791.—Wyeth's Method of Bloodless Amputation at the Hip-joint.

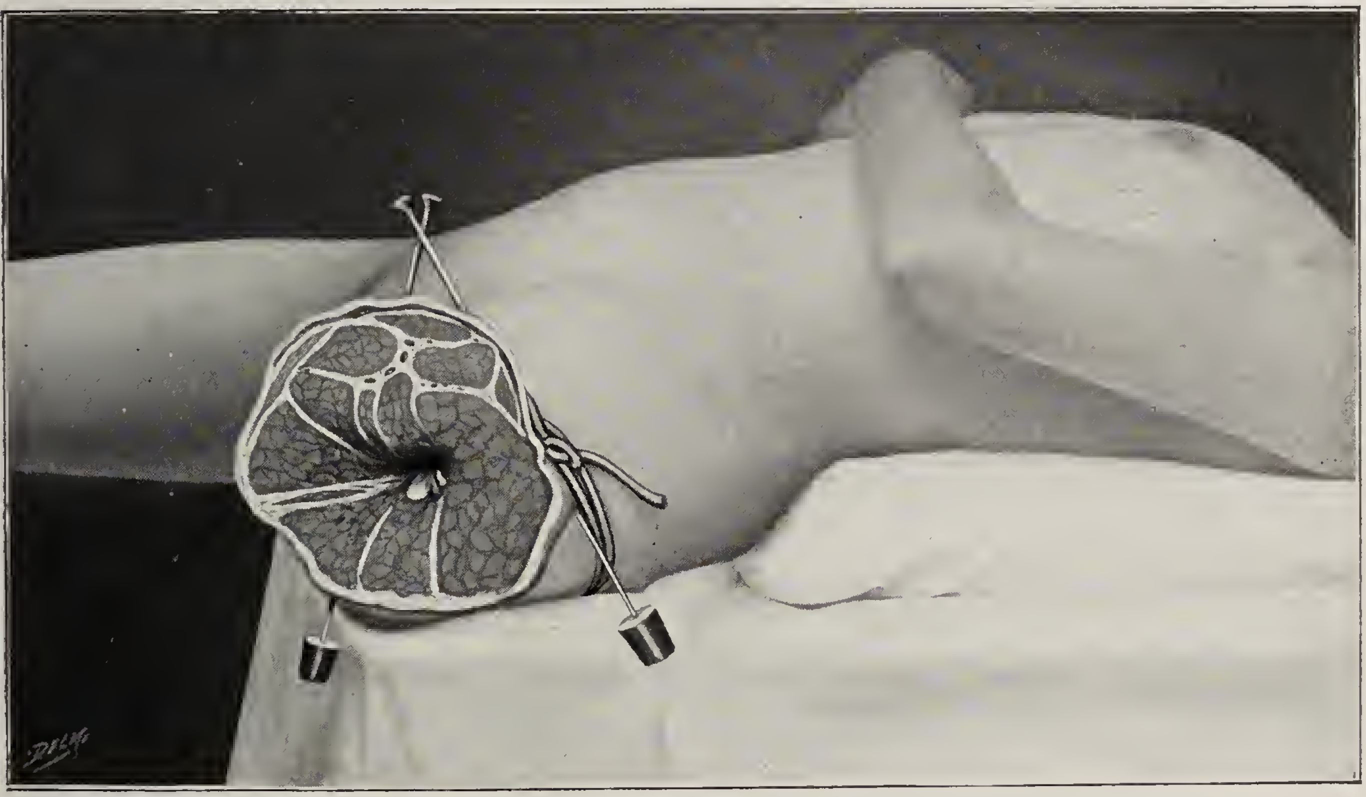

Fig. 792.—Wyeth's Method of Bloodless Amputation at the Hip-joint.
Shows the appearance of the parts after removal of the bone.

half of the limb, the other encircling the other half. Elastic constriction of the thigh below the pelvis until the amputation has been completed and the principal vessels have been tied is then made. Should an elastic cord not be available, a cord made of sterile gauze may be substituted and tightened by a lever of some kind, as in applying the ordinary Spanish windlass.

Should the pins of Wyeth not be at hand, Senn's method may be employed with satisfaction. Since, however, some blood must be lost during the preliminary dislocation of the head of the femur, the method cannot claim to be so entirely a bloodless one as Wyeth's.

After the insertion of Wyeth's pins and the application of the constricting tube, the further steps of the operation are as follows: The patient is brought to the lower end of the table, with the hip projecting well over the edge, and a circular incision is made six inches below the constricting tube down to the deep fascia; this is joined by a longitudinal incision over the trochanter major, extending from the constrictor to the level of the circular incision (Fig. 791). The cuff is reflected to the level of the lesser trochanter. The muscles are cut at the line of the retracted cuff, the capsule is opened freely, and the fibrocartilaginous structures of the cotyloid ligament are divided posteriorly. The thigh is now strongly flexed and adducted to dislocate the head of the bone, and, with the thigh as a lever, the head is pried out, the ligamentum teres divided, and the limb removed. The vessels are now ligated, the constrictor removed, and the pins withdrawn. Drainage is provided for and the flap sutured.

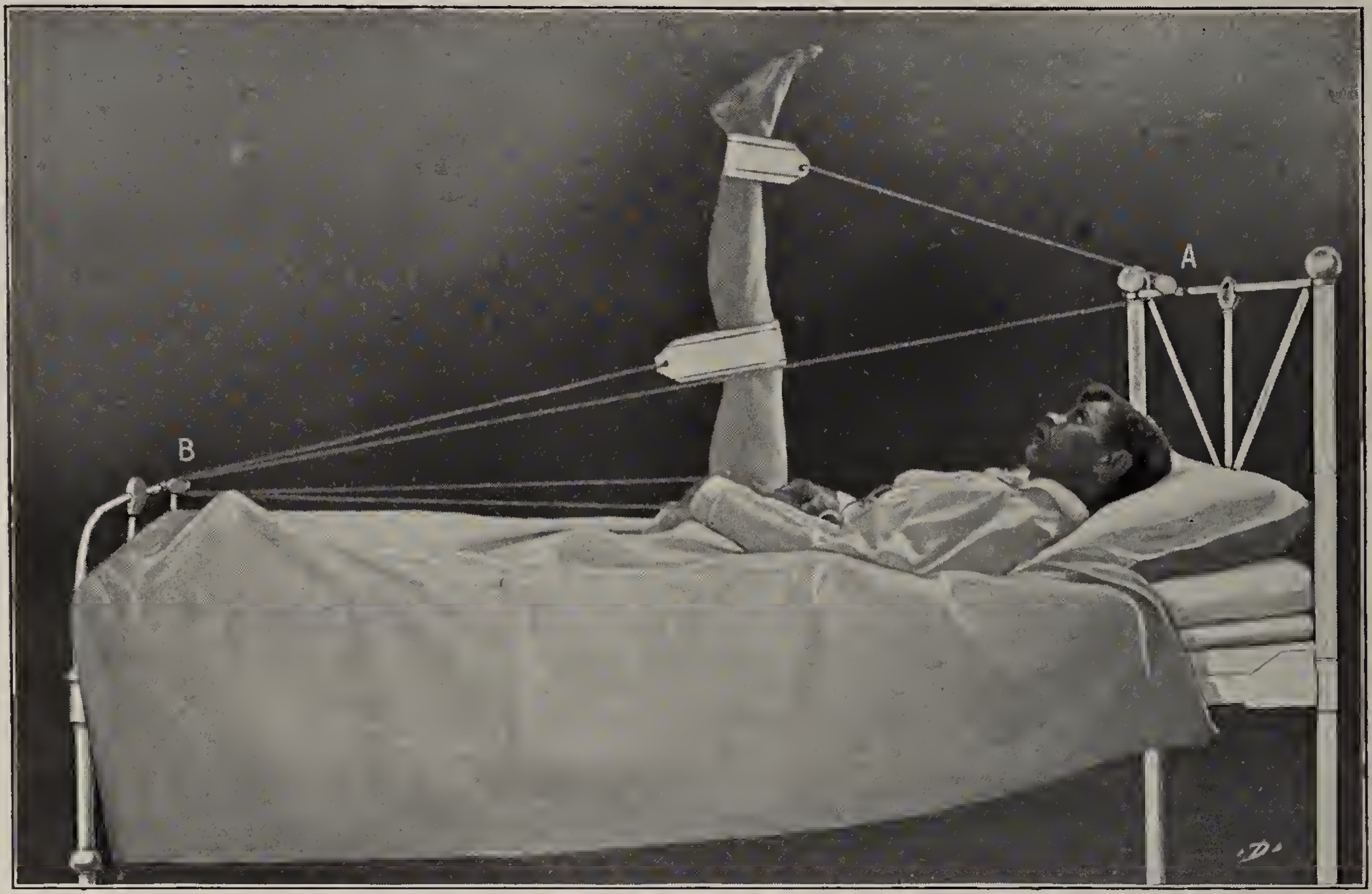

Fig. 793.—Dry Stretching of the Sciatic Nerve.
A, Single pulley; B, double pulley.

Wyeth makes a second circular incision down to the bone, six or eight inches below the first, and removes the muscular structures between to facilitate access during the dislocation. This is not generally deemed necessary.

Interilio-abdominal amputation (removal of the entire lower extremity, including a portion or all of the ilium) has been employed in malignant growths situated in the region of the hip and upper portion of the thigh (see page 539) and in those springing from the ilium. The lines of incision and formation of the flaps will depend on the situation of the tumor. Ligation of the iliac vessels of the corresponding side prior to forming the flaps is not advisable (Morestin). The horizontal ramus of the pubic bone is divided with the Gigli saw, the attachment of the rectus muscle being preserved, the muscles attached to the ilium divided, and the descending ramus of the pubic bone sawed through. The ilium is now divided with the saw from the crest to the greater sciatic notch (Keen). Or the division may be made through the rami of the pubis and ischium and the sacroiliac synchondrosis. The Esmarch bandage should be applied to the limb before the amputation in order to preserve the blood. In uniting the muscle and skin flaps provision is to be made for drainage.

Stretching of the Sciatic Nerve.—Indications: Intractable sciatic neuralgia (sciatica) constitutes the principal indication. It has been proposed also to stretch the nerve in degenerative disease of the posterior columns of the cord (Erlenmeyer) and in the peripheral paralysis of spinal concussion (Riedel). In the first named the improvement has proved but temporary, and in the second further experience is wanting.

The method of dry stretching under an anesthetic should be first employed. With the leg fully extended the thigh is flexed forcibly upon the abdomen. The after-treatment consists of the stretching of the nerve several times daily by the patient himself, by means of the apparatus shown in figure 793. In mild cases this alone may suffice. Dry stretching failing, stretching by open incision may be resorted to.

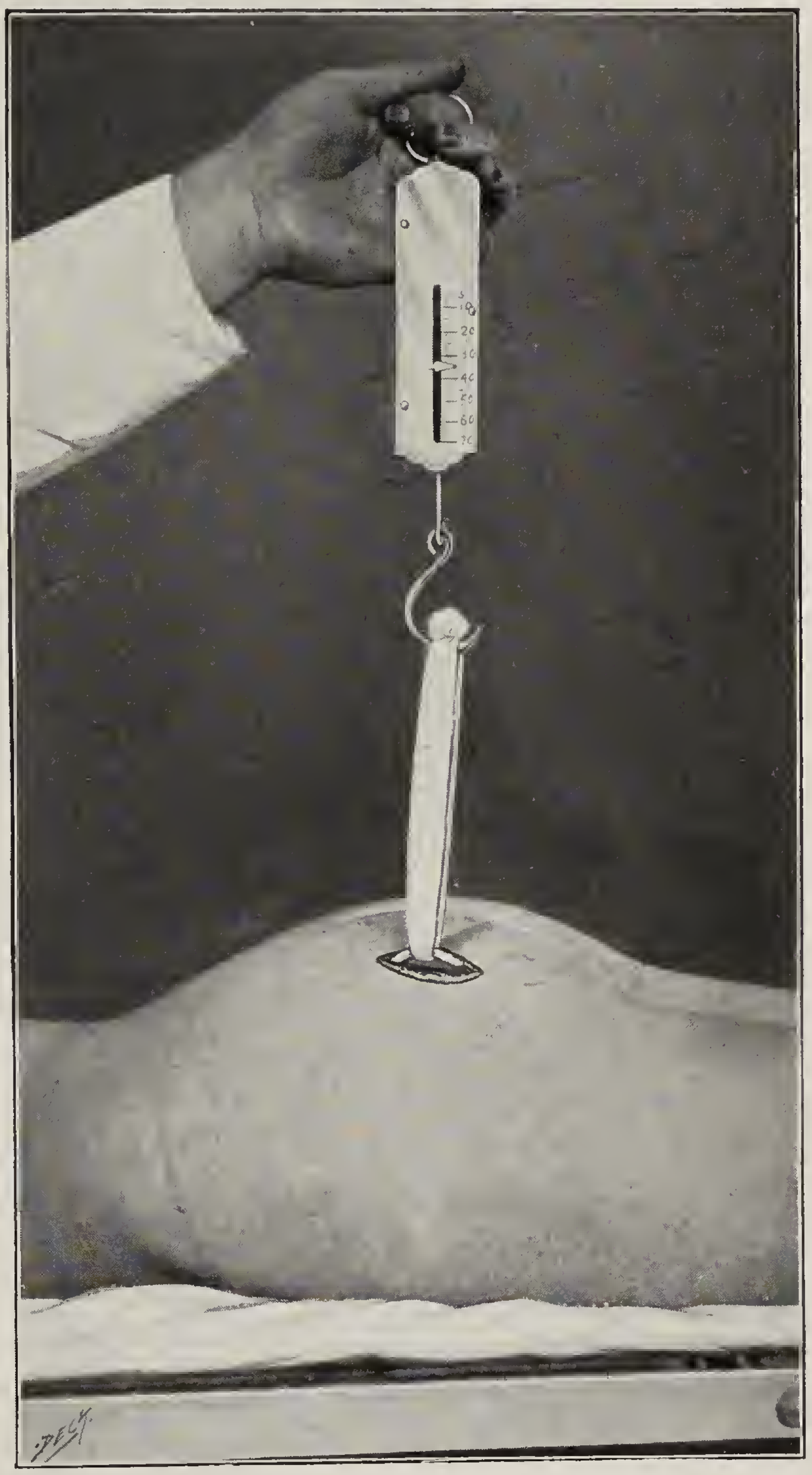

FIG. 794.—STRETCHING THE SCIATIC NERVE BELOW THE PYRIFORMIS.

Operation.—The patient is placed on the opposite side or on the abdomen. A 3½ inch vertical incision is made two-thirds of the distance from the tip of the great trochanter to the tuberosity of the ischium. The skin and fascia are divided and the lower edges of the gluteus maximus exposed. The group of flexor muscles of the leg is identified at their origin at the tuberosity of the ischium. The nerve is found in the acute angle which these muscles form with the lower edge of the gluteus maximus; or the fibers of the latter may be separated in their normal direction and the nerve identified where it appears below the edge of the pyriformis muscle. It is isolated and a piece of gauze passed beneath it and tied in a loop. The hook of a spring balance is caught in the loop and the nerve stretched with about 30 pounds tension in the adult (Fig. 794).

THE REGION OF THE KNEE, KNEE-JOINT, AND LOWER HALF OF THE THIGH

Injuries of the Knee-joint.—The knee-joint is more exposed to contusions than any other of the large joints of the extremities. This is due to the great extent of its capsule and its relatively superficial situation. In addition, the synovial membrane is tightly stretched over the condyles when the leg is flexed, its exposure to injury in the presence of a contusing force being thus increased. Under these circumstances its vessels are easily torn, and hemorrhage into the joint or hemarthrosis results. Quite a large accumulation of blood takes place in the large synovial sac of the joint. This hemorrhage is not an infrequent cause of hydrarthrosis.

The condyles of the femur are rarely the seat of intracapsular fracture, the thinner portion of the bone above yielding first. Transverse fracture of the patella occurs more frequently, and this is likewise of necessity a source of hemorrhage into the knee-joint. Separation of portions of the articular surfaces of the condyles may be caused by blows from angular bodies. **Floating** or **free bodies** in the joint are caused by separation of the cartilaginous portions.

So-called **sprains** of the knee-joint, the force carrying the leg in forced adduction, abduction, flexion, extension, or rotation, may result in the tearing away of portions of the ligamentous bony attachments. These injuries are really in many instances intra-articular fractures by avulsion (Dittel). There may be considerable hemorrhage within the joint, the cavity of which may refill after puncture and aspiration, the resulting hydrarthrosis in many of these cases of so-called traumatic synovitis being really due to a pre-existing hemarthrosis.

The infrequency of **dislocations of the knee-joint** is to be attributed to the remarkable solidity of the ligaments of the joint, extreme tension of these producing fracture by avulsion, rather than rupture of the ligaments themselves (see page 549).

Gunshot Wounds of the Knee-joint.—These are very frequently observed in military practice and are not very rare in civil life. In no other joint, however, do the bones themselves so frequently escape injury, the latter amounting only to a wound of the capsule. The bullet may enter at one lateral edge of the patella, or the site of the alar ligaments (plica synovialis patellae, Henle), and emerge at the other edge; or it may pass anteroposteriorly from the ligamentum patellae, perforating the crucial ligament, and issuing at the popliteal space (G. Simon). The majority of gunshot wounds of the knee-joint, however, inflict more or less damage on the bony structures. **Perforating** shot-wounds form furrows in the spongy joint ends. **Splintered fractures** involving the joint are more frequently observed in the femur, where a considerable portion of the diaphysis with its rigid cortical lamella is encased in the joint capsule. On the other hand, the capsular attachment at the tibia is just below the anterior edge, and for this reason splintered fractures of the tibia, as a rule, are extra-articular. Here, too, in a small proportion of cases, the fissure may extend into the joint.

Prognosis.—The dangers arising from gunshot injuries of the knee-joint relate to the suppurative processes, which, according to the damage inflicted and the violence of the infection, develop slowly or rapidly. In **civil life** these injuries are usually inflicted by the common old-fashioned class of firearms, and the most disastrous results sometimes follow. At periods of time varying from even less than twenty-four hours to several days, and, in rare instances, even to weeks, the joint may show signs of infection. The infective process usually commences outside of the joint and extends to the latter either along the bullet track or through a fissure in the bone. The region of the knee swells to almost double its normal circumference and the skin becomes edematous and hot. Violent pain in the joint is experienced, radiating to the leg and thigh and increased by the slightest touch or jar. Rigors and chilly sensations are present, followed by high temperature. The infection soon extends to the thigh and afterward to the leg, and phlegmonous infiltration of the subfascial and subcutaneous connective tissue is rapidly developed. Septicemia from absorption of septic products, and pyemia due to thrombosis and the transport of infectious thrombi to distant organs, are frequent sequences, ending in death. In the more favorable cases suppuration advances more slowly, is less extensive, and finally terminates in obliteration of the joint surfaces and ankylosis.

In **military practice,** particularly when the modern firearms are employed, the results are vastly better. During the Greco-Turkish war I had the opportunity of observing a number of cases of gunshot wounds of the knee-joint at the military hospitals at Athens, through the courtesy of Professor Galvani and the Secretary of War, and in the Yildiz Hospital at Constantinople, through the courtesy of Professor Djemil Pasha, Surgeon-General of the Turkish army. The Turkish wounded were injured by the Gras weapon, a discarded arm of the French army of the older type and the arm generally employed in the Greek army. On the other hand, the Turkish troops were armed with the more modern Martini rifle, and, in consequence, there was a better showing and fewer resections among the Greeks who were wounded by this weapon than among the Turks who were injured by the Gras weapon.

Treatment.—Absolute rules for all cases cannot be laid down in the treatment of gunshot injuries of the knee-joint. There is opportunity for the exercise of judgment in selecting the cases in which operative interference will become necessary, and those in which conservatism must prevail. Between the dictum put forth by Stromeyer, Wilms, and their followers, that every gunshot wound of the knee-joint demands amputation to escape the subsequent dangers of the injury, and the extreme conservatism displayed by recent writers, who would apparently expect every gunshot wound of this joint to recover without complication and with a perfect functional result, the truth may be found at different points. It is true that many cases will recover with practically no treatment whatever; it is equally true that many cases will die if not treated by resection or amputation, and may perish in spite of these operations. Of this, however, we may be certain, namely, that while in civil life the differences are not so marked, if we compare the present experience with that of a decade or two ago, in military practice a vast improvement is to be noted. This discrepancy is due to several factors, chief among which are the differences in the arms employed; the fact that the soldier is provided with an antiseptic first-aid packet; and, finally, that the wounded man in civil life may fall into the hands of an incompetent person, coming under the care of a surgeon only when suppuration is well under way, while the wounded soldier falls at once into the care of an army surgeon whose training at the present day is along the lines of prevention of septic conditions.

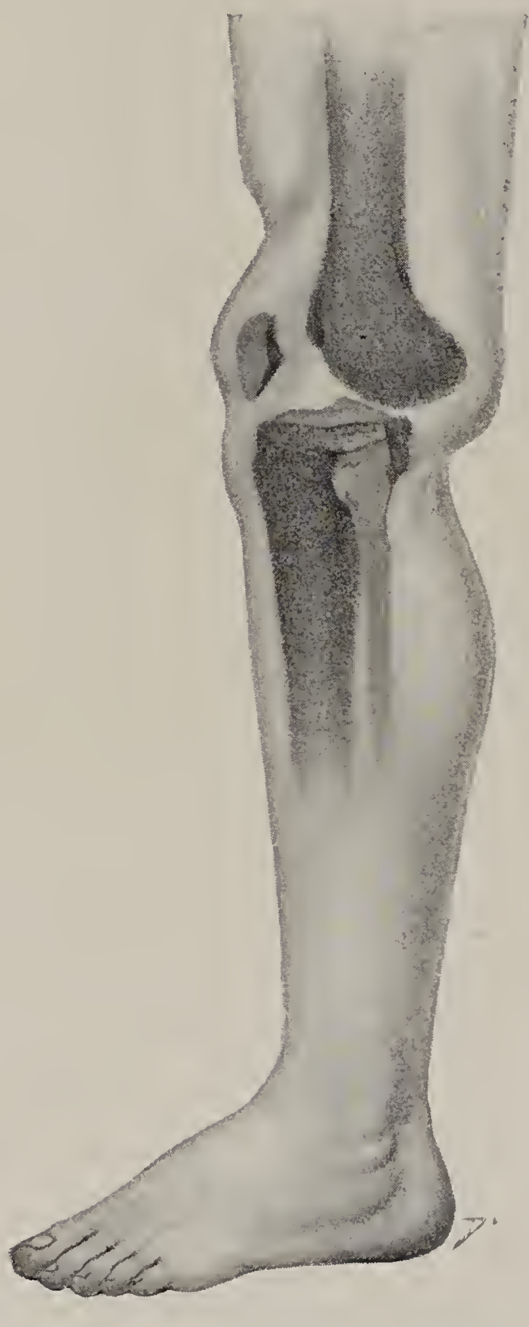
Fig. 795.—Forward Dislocation of the Tibia.

The treatment of cases of gunshot injuries of the knee-joint will include (1) careful and complete **antiseptic cleansing of the surroundings,** the application of copious **sterile** or **antiseptic dressings,** and **immobilization. There must be no probing.** A careful watch must be kept for the advent of suppurative processes, as evinced by excessive pain, and chills followed by alternate rise and fall of temperature. These should be met by **incision and drainage of the joint** and the removal of foreign bodies, such as the bullet, if this has not already escaped, bits of clothing, etc., and splintered portions of bone, and even larger portions of bone if these are greatly damaged (**primary atypic resection**). (2) **Typic resection** of the knee-joint may become necessary. By this is meant a methodic resection in comparison with the last named. It is indicated in further development of suppuration and persistent high temperature despite the measures already employed. The resection in this case constitutes an antiseptic measure, and under these circumstances is an **intermediate** operation. (3) **Amputation of the femur.** This is the last resort in all cases in which the more conservative measures of treatment have failed and in cases in which the patient comes to the surgeon too late for any conservatism except that which relates to life itself. The amputation here is a secondary procedure. Finally, cases will occur in which the presence of extensive injuries to the bones and soft parts, *e. g.*, rupture of the popliteal artery and vein, and of the nerve, will demand **primary amputation.**

"Internal Derangement of the Knee-joint."—Certain affections of the knee-joint have been described under the somewhat vague term of "internal derangement." The three symptoms which these affections have in common are (1) sudden pain while the joint is in use; (2) disability for the time being; (3) a resulting effusion in the joint. In recent years, owing to the greater safety of exploratory incisions in the knee-joint, and hence their increased frequency, surgeons have been able to determine at least four separate conditions formerly grouped under this name. These are (1) papillary synovitis; (2) detachment of the ligamenta alaria; (3) injuries of the semilunar cartilages; (4) free bodies in the knee-joint.

Arthritis Deformans.—This is comparatively frequent at the knee-joint, both in its monarticular form following joint fracture, and in the course of an old hydrarthrosis, as well as in the polyarticular variety attacking those in advanced age, in which case both knee-joints, and the hip-joints also, may be involved. The treatment consists in thermal baths, massage, and passive movements. The inflammatory processes are sometimes held in check, but complete cure is never obtained.

Traumatic Dislocations of the Knee-joint.—Traumatic dislocations of the knee-joint are to be distinguished from certain pathologic dislocations occurring in the course of disease of the knee-joint. **Complete dislocations** of the knee-joint due to force are, as a rule, compound, with such extensive coincident injuries as to demand **primary amputation** of the thigh. The mortality of this class of injuries is high, owing to the extreme shock and loss of blood. They usually result from machinery accidents or similar mishaps. The dislocation may occur either **forward, backward, inward,** or **outward.** The forward dislocations are almost invariably due to **hyperextension of the knee-joint,** the fixed point on which the hyperextension takes place in order to permit separation of the posterior articular surfaces in the popliteal space being the anterior edge of the tibia. A secondary movement of flexion occurs, which forces the tibia from behind forward. Occasionally, though rarely, this dislocation is caused by a fall from a height, when the femur is forced backward. The dislocation is recognized without difficulty; the articular surface of the tibia lies beneath the tense skin and the condyles are felt in the popliteal space. Both the lateral and the crucial ligaments are torn, as a rule. Occasionally one of the lateral ligaments is preserved. **Reduction** is effected by traction and by forcing the head of the tibia backward. The method of making first hyperextension and then flexion is objectionable, on account of the dangers of rupture of the vessels and nerves.

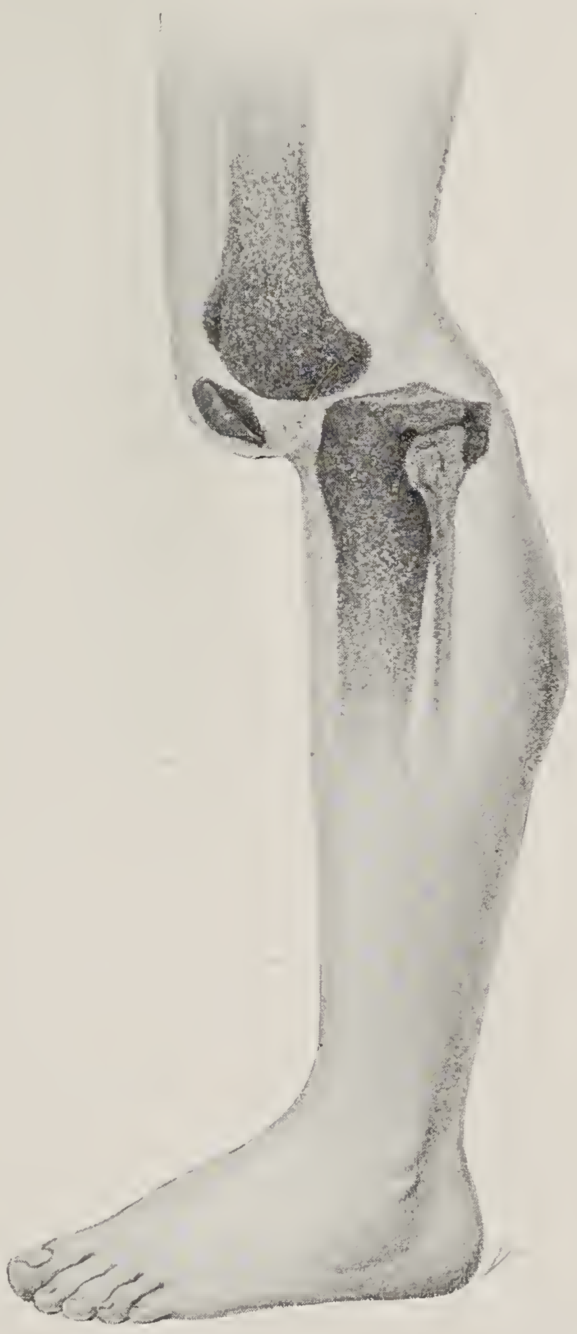

Fig. 796.—Backward Dislocation of the Tibia.

Dislocation of the tibia backward is due to direct force, the tibia being forced backward by a blow from in front. This dislocation may not be complete. **Reduction** is accomplished by distraction of the joint surfaces and direct coaptation.

Lateral dislocations occur from lateral inflection caused either by falling on the feet, or by sinking under a heavy weight. It may result from the leg's being caught and firmly held, the femur being forced in either one direction or the other. The changed shape and increased width of the knee-joint, with the articular surfaces in distorted positions, are characteristic. The head of the tibia and that of the patella are both dislocated in the same direction. **Reduction** is effected by forced separation of the joint surfaces by traction, and pressure made on the joint ends in opposite directions. Should this fail, the joint should be opened, when it will probably be found that the condyle has passed through a buttonhole-like slit in the capsule. By enlarging this, reduction may be effected by simple adduction or abduction (H. Bruns).

Dislocation of the head of the fibula from the head of the tibia is rare. I have observed three cases in which the injury appeared to be due to excessive retraction of the biceps.

Injuries of the Menisci.—These injuries constitute one of the lesions in the train of symptoms to which the name "internal derangement of the knee-joint" has been given (*vide supra*). **Complete dislocation of a meniscus,** the interarticular cartilage separating entirely from its relations with the tibia and femur, is scarcely possible. **Incomplete dislocation,** in which the corresponding portion of the meniscus leaves its normal position between the tibia and the femur, occurs from rupture of its attachments to the capsule. The cartilage itself may be torn or ruptured. As a rule, the patient experiences a sudden pain when the weight is thrown on one limb in abduction and the latter rotated, and he is temporarily unable to walk. The ruptured capsular attachments, as a rule, are not repaired, and similar attacks are liable to occur on provocation (**habitual dislocation of the meniscus**).

Injuries of the menisci or semilunar cartilages usually result from sudden twisting movements of the body while the weight of the latter forces the corresponding foot firmly against the ground. Lesions of the semilunar cartilages may also result from direct injury, as occurred in a case under my care, in which the cartilage was ruptured.

The character of the injury will vary with the amount of force exercised, and with its direction. The cartilage may be simply rendered more mobile by the overstretching of its attachments, or one or another of its connections may be torn loose. It may be the seat of fracture, either partial or complete, the line of separation running either lengthwise or crosswise to the cartilage.

The internal semilunar cartilage is more frequently displaced than the external. This is due, first, to the greater frequency with which the weight of the body is thrown on the internal condyle when rotation of the body is performed during active exercise, as, for instance, in football contests and games of lawn tennis; and, second, to the fact that this cartilage describes only a half circle in shape and is but indifferently secured from displacement by comparatively slight attachments to the tibia at its anterior and posterior extremities, as compared with the external semilunar cartilage.

Once the cartilage has been loosened or detached the symptoms may recur on the slightest provocation. Occasionally, after the first attack, the hemorrhage within the joint is sufficient to lead to the formation of adhesions. These, provided the joint is kept immobilized, may suffice to fix the cartilage in its normal position. Not less than eight weeks will be required to accomplish this. Even in these cases the patient is prevented from indulging in active exercise from a well-founded fear of recurrence. Unless there are some very positive contraindications to operation, an **arthrotomy for the removal of the offending cartilage** should be performed for the recurrent cases, since experience shows that patients do not feel the loss of these structures at all. Attempts to fix the cartilage in position will prove only futile.

The technic of the operation for the removal of the semilunar cartilage is as follows: An Esmarch bandage is applied and the leg flexed at a right angle. An incision is made commencing at about the level of the lower border of the patella, and extending downward, parallel to the border of the ligamentum patellae, nearly to the level of the articular surface of the tibia. It is then curved so as to follow the latter for about the same distance in the direction of the corresponding condyle. The skin and underlying structures are then turned back in a flap and the capsule opened in the space thus exposed by a horizontal incision. The cartilage is grasped by a tenaculum, its anterior attachments severed and drawn out so as to enable the operator to reach its deeper attachments, which are divided with blunt scissors. It is not always possible to reach these attachments, in which case it will suffice to divide the cartilage itself as far back as possible.

If care has been taken to prevent blood from entering the joint the wound may be closed at once, the capsule being sutured separately with fine catgut. If blood has entered the joint, this should be **wiped dry with sterile gauze.** Irrigation of the joint should not be practised, nor should drains be employed, since these will tend to the formation of adhesions. The limb is **immobilized** on a posterior splint, with lateral splints of light bass-wood, or put up in plaster-of-Paris for a week, after which the ordinary gauze dressings suffice to restrain the movements of the joint as much as necessary. The patient should be encouraged to move the limb as much as possible after ten days have elapsed. Should there be a tendency to restriction of flexion, this should be corrected by **passive movements and massage.**

Detachment of the Ligamenta Alaria.—These folds of synovial membrane lie on the sides of the ligamenta mucosa as these pass from the intercondyloid fossa to the lower margin of the patella. One or both of these may be detached from their upper attachments and lie loosely in the joint, where they may be caught between the articular surfaces and give rise to the symptoms of "internal derangement."

The **treatment** consists in removal through a curved incision which closely follows the inner edge of the patella and which may be extended in an upward or downward direction if necessary. All bleeding of the skin portion of the incision should be arrested before the capsule is opened. The incision should be sufficiently free to permit exploration of the joint, in order to make sure that the symptoms are not due to either a loose body or papillary synovitis. The loose ends of the detached ligament should be cut off close by curved scissors and removed. The wound is closed and the after-treatment conducted in the usual manner. No ill results follow the removal of these folds of synovial membrane.

Dislocations of the Patella.—There are three forms of dislocation of the patella, namely, lateral dislocation, either outward or inward, vertical dislocation, and rotation dislocation (Malgaigne). Vertical dislocation is comparatively rare (21 out of 120 published cases, Streubel).

Lateral dislocation on the external condyle is the most frequent. This may be due to the more vertical direction of the inner portion of the saddle-shaped posterior surface of the bone, or to the fact that the majority of those who suffer from this injury are the subjects of **genu valgum,** in whom the projecting internal condyle forms a plane inclined from the inner to the outer side, by means of which the patella is impelled in the outward direction (Malgaigne, Isermeyer). Hueter demonstrated a fossa at the external condyle which, together with the intercondyloid notch, receives the greater portion of the articular surface of the patella as the knee is flexed. As the knee is flexed after extension the longitudinal ridge of the patella adapts itself to this furrow, the action of the quadriceps extensor tending to lead it to and beyond this point; in case of a slight rupture of the capsule, the patella may rest upon the external condyle (Fig. 797).

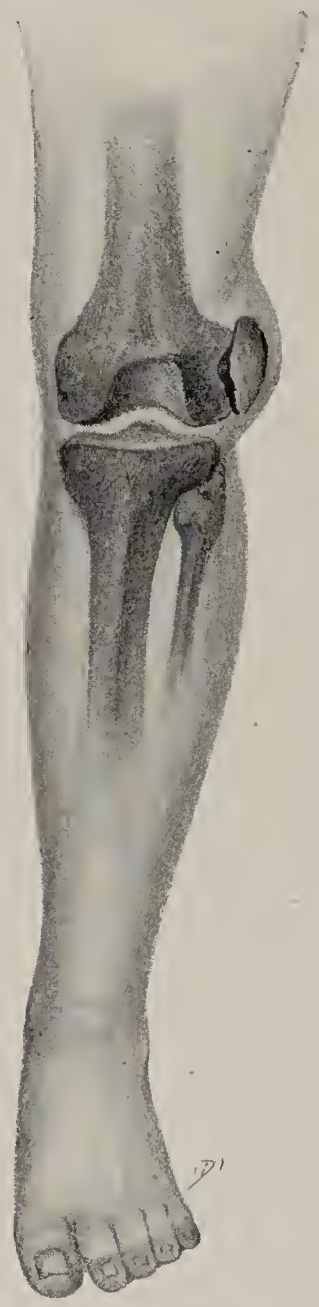

FIG. 797.—OUTWARD DISLOCATION OF PATELLA.

In vertical dislocation of the patella (Fig. 798) the internal or external lateral edge of the patella lies in the median depression of the anterior surface of the femur in which the bone normally slides during flexion and extension of the knee-joint. It is supported in this position by the articular surface directed either outward or inward. Most frequently the inner edge serves for the support, probably because it carries a small longitudinal articular facet. Muscular action is said to produce this dislocation through isolated contractions of the vastus externus or the vastus internus muscle, with the knee bent laterally or rotated with great force. The capsule is torn to a considerable extent.

Rotation dislocation is probably a transitory form from the vertical position to that of half rotation. The joint facets may be palpated through the tightly stretched skin (Fig. 799).

The **diagnosis** of dislocation of the patella, particularly of the external variety, is not difficult. **Reduction** is usually accomplished by simply pushing the bone back into place. Difficulties are sometimes met with, owing to the fact that the bone is tightly grasped by the opening in the capsule. Malgaigne recommended drilling into the bone and using the drill as a lever to manipulate the bone into its proper position. Gaulke reports a case in which after several hours' trial under an anesthetic he was able to effect reduction. **Physiologic reduction** consists in reversing the movements during which the dislocation occurred, *i. e.*, flexing the knee firmly and rotating the patella laterally, its longitudinal ridge being thereby forced again into the groove of the external condyle and thence into the intercondyloid notch.

Congenital dislocation of the patella is a very rare condition. It may be complete or incomplete. In the former the dislocation disappears on flexing the knee. In the latter the luxation becomes complete when flexion is made. In a third group of cases the patella, already apparently in complete dislocation, is forced out further on the external condyle by flexing the knee. Congenital dislocation sometimes occurs in several members of the same family. Attempts to correct the deformity by orthopedic apparatus are liable to result in arrest of development in the parts under restraint.

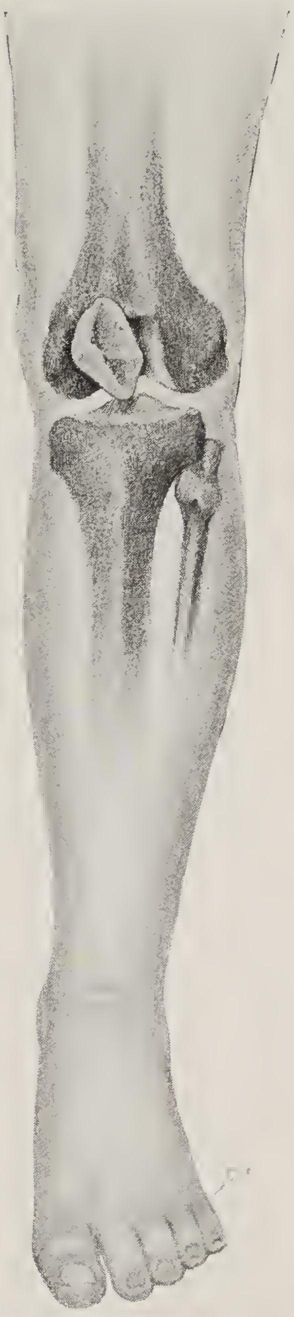

Fig. 798. — Vertical Dislocation of Patella.

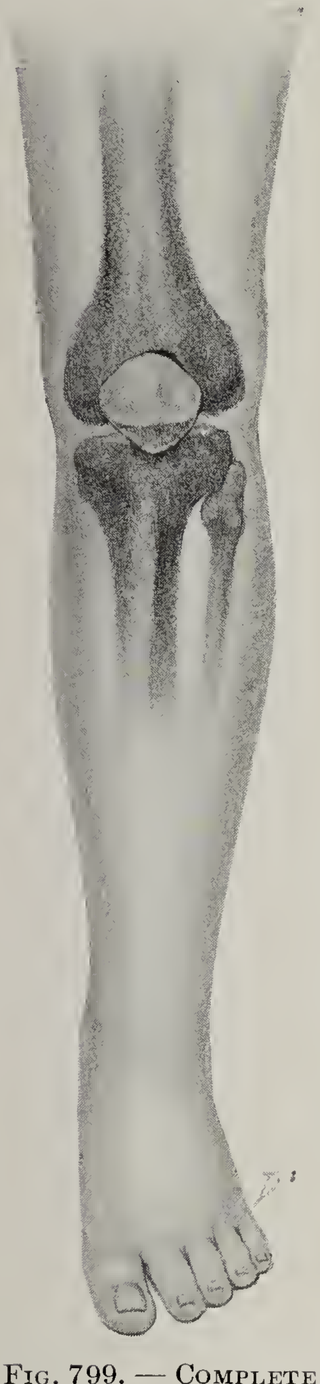

Fig. 799. — Complete Turn of the Patella.
Articular surface looking forward.

Fracture of the Patella.—This fracture is due, in the majority of instances, to muscular contraction, particularly in attempts to save the body from falling backward by means of the powerful quadriceps extensor. The same forces may rupture the quadriceps extensor or the ligamentum patellae; with the knee flexed, however, the patella is forced against the condyles of the femur, while the trunk, in falling backward, produces simultaneously extension at the hip-joint. The result is extreme tension on the extensor apparatus, the patella being held by its unyielding ligament so that it rests on its posterior vertical ridge, this latter becoming the point on which is exerted the accumulated energy or strain of two opposing forces. In the attempt to save the body from falling, without the addition of the backward motion of the trunk and the consequent extreme extension of the hip-joint, the contraction of the powerful group of muscles constituting the extensor apparatus of the leg, with the knee flexed and the patella fixed, will cause fracture of the latter to take place (Fig. 800).

The fracture occurs sometimes with an audible sound. The limb becomes at once useless, and a gap, more or less distinct, is seen on the anterior surface of the knee-joint (Fig. 801). The prepatellar structures do not give way at the same time, stretching at first to their utmost and then separating by a tearing lesion so that irregularly fringed margins are formed. These shreds of inelastic fibrous tissue, previously overstretched so as to lose their resiliency, become entangled in the rough fractured surfaces, specially that of the upper fragment, which becomes tilted forward in a manner to present the plane of its fractured surface to the strips of torn tissue, while the latter are still further forced on the projecting spiculae by atmospheric pressure (Macewen). The bridge of aponeurotic structure on the anterior surface of the patella does not always give way; it will, however, in its relaxed condition fall between the fragments and prevent accurate coaptation of the fractured surfaces.

The direction of the line of fracture is usually transverse, though it may be either vertical or oblique. In **transverse fractures** the line of fissure is generally below the center of the bone, the lower fragment usually being the smaller. In **comminuted fracture** either of the original fragments may be again broken in a longitudinal or oblique direction. In **vertical** or **longitudinal fracture** the bone parts in its long diameter. In **oblique fracture** the line of fissure usually runs diagonally from the lower and outer to the upper and inner angles of the bone. It is probable that in both of the last named, as well as in comminuted fracture, direct violence is added to the causes already described. **Compound fracture** also results from direct violence.

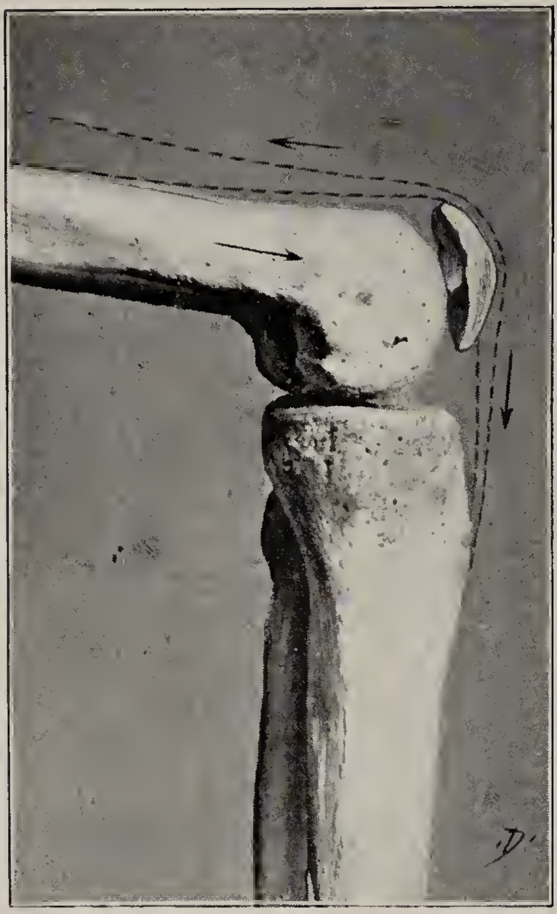
FIG. 800.—MECHANISM OF TRANSVERSE FRACTURE OF THE PATELLA.
The arrows show the direction of the force.

In transverse fracture with the tearing of the prepatellar aponeurotic structures, **separation of the fragments** is marked and constant, and disability complete. In longitudinal and oblique fractures this separation may be very slight, and scarcely any disability may exist. The expansions of the vasti muscles, which extend along the sides of the patella, as well as the fibrous tissues on its anterior surface, escape the extensive injury found, as a rule, after transverse fracture.

Predisposition to fracture of the bone of the opposite side is said to follow transverse fracture of the patella. This has been thought to be due to impairment of function, owing to long ligamentous union between the fragments. It occurs, however, in cases in which bony union has been obtained by suturing the fragments.

Union by bone, except under rare circumstances, up to a comparatively recent period was the exception rather than the rule. **Ligamentous union** is mainly due to the interposition of torn shreds of the fibrous aponeurotic structures constituting the floor of the prepatellar bursa and lying on the anterior surface of the bone. These shreds become firmly embedded on the surface of the fragments and prevent bony union. Excessive effusion of blood within the joint and wide separation due to retraction of the upper fragments may also become factors of more or less importance in preventing union by bone, and favoring ligamentous union. In the exceptional instances in which bony union takes place without arthrotomy and suture of either the bone or the capsule, or both, this is probably due to the fact that the prepatellar structures do not become greatly overstretched before giving way.

In the **diagnosis** of fracture of the patella the history of the accident, loss of function of the extensor muscles of the leg, together with the separation of the fragments, are prominent points in the transverse variety. **Crepitus** is not usually obtained, owing to the presence of shreds of fibrous tissue on the fractured surfaces, or to the separation of the fragments. In vertical and oblique fractures crepitus may be present; in fact this, with mobility of the fragments on each other, in the latter case frequently constitutes the only symptoms of the injury.

Prognosis.—With the exception of those cases in which the joint is opened, the shreds of fibrous tissue removed and the fragments subsequently united by suture, and the rare instances in which apposition of the bony surfaces is obtained because of the absence of these shreds of fibrous tissue, as well as cases of vertical and oblique fractures, the limb never becomes as functionally perfect as before. While the defective action of the quadriceps extensor muscle is compensated for to a considerable extent by the psoas and adductors, ordinary walking thus being but slightly interfered with, yet certain other and useful movements are greatly hampered or prevented altogether. A certain amount of atrophy of the quadriceps extensor is present, which may be due to non-use, or to coincident injury of the muscle itself (Bergmann, 1887). In ligamentous union the position of the fragments, rather than the extent of the separation, governs the functional usefulness of the limb. In those instances in which the fibrous connection is so placed as to produce **tilting of the fragments,** the functional disability will be greater, even though the separation is comparatively slight, than when the hiatus between the fragments is considerable, but the ligamentous connection is so situated as to support the latter in a position to permit the proper direction of the force required to extend the leg. In cases in which bony union is obtained complete restoration of the usefulness of the limb follows, provided no organic changes in the joint producing ankylosis and no injury to the quadriceps extensor femoris muscle occur. In compound fracture, or that complicated with injury to the soft parts sufficient to produce a wound communicating with the joint, the prognosis is more unfavorable, owing to the dangers arising from septic processes.

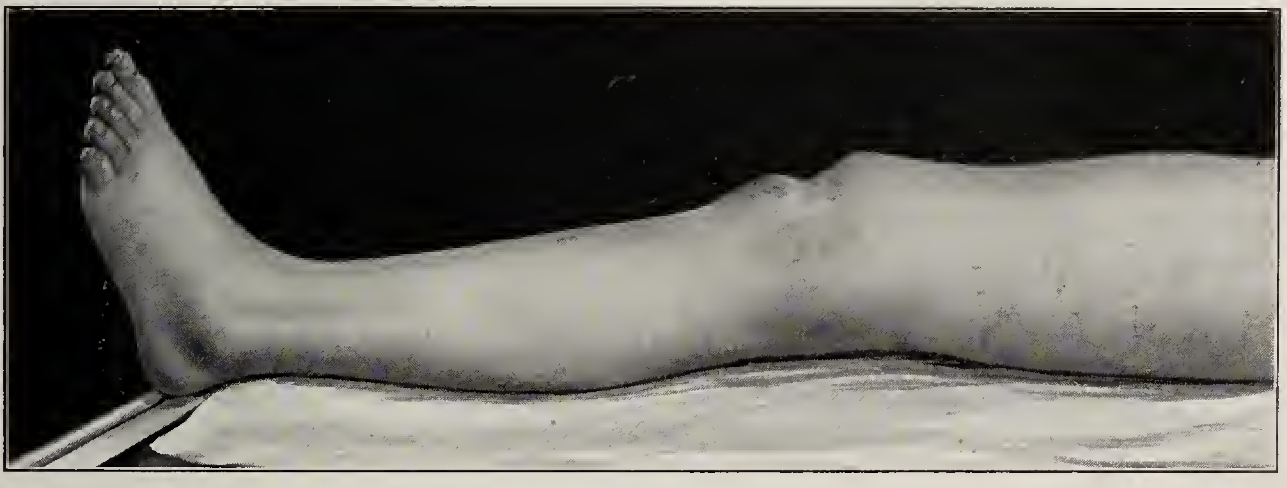

Fig. 801.—Fracture of the Patella with Wide Separation of the Fragments.

Complications.—Rupture of a vessel, usually one of the articular arteries, may lead to the occurrence of a **hemarthrosis.** Another serious complication is the occurrence of **injury to the periosteum,** followed by caries or necrosis. This is particularly liable to occur in compound fractures from the occurrence of septic inflammatory processes following infection, which can be only exceptionally avoided. More or less **injury to the extensor muscles** by the tearing of their fibers, blood-vessels, nerves, etc., may occur from the same force which produces transverse fracture, when this is due to the causes already enumerated. **Rupture of the joint capsule,** particularly of that portion lying beneath the tendon of the quadriceps extensor (Riedel), is a complication which derives its greatest importance from the relation which it bears to the operation of immediate suture of the fragments. The occurrence of **severe contusions of the soft parts** in the neighborhood of the joint is likewise of importance in the same connection.

Extreme and rapidly developed tension within the joint cavity, giving rise to pain, is due to the occurrence of hemarthrosis. The use of the exploring aspirating-needle will clear up any doubt on this point. The supervention of extensive suppurative processes will always endanger the vitality of the osseous structure through septic periostitis and ostitis. Rupture of the capsule in the recess beneath the quadriceps extensor muscle is to be suspected if the effusion within the joint disappears rapidly after the application of a pressure bandage.

Treatment of Fractures of the Patella.—The first indication is to **lessen as much as possible the amount of effused blood in the joint.** The limb should be flexed at the hip, elevated, put at rest on a posterior splint, and an ice-bag applied. Alternate elastic compression and massage have been recommended (Metzger). In the rare cases in which the effusion in the joint is still large at the end of three days it may be removed by aspiration. The best site for the puncture is on the inner edge of the patella at its middle.

Accurate coaptation of the fragments in transverse fractures should be the next step. When the swelling has subsided a well-padded posterior splint, or a gutter splint, is to be applied, and the fragments approximated by strips of adhesive plaster so applied as first to fix the lower fragment in position and then to draw down the upper fragment as much as possible by means of a broad U-shaped piece of adhesive plaster, which is laid above the fragment, with its two ends carried back of the splint and below the joint (Fig. 802). The entire limb and splint are now bandaged by oblique turns of the bandage (Fig. 803); the thigh is flexed by raising the foot on a pillow before the dressings are applied.

Non-interference, beyond a pillow support and evaporating lotions, has been followed by good ligamentous union (Pridgin Teale). A method of ambulatory treatment in connection with **massage of the muscles of the thigh and leg** (J. P. Zum Busch) has also been recommended.

Securing the Fragments in Position by Arthrotomy and Suture.—This is the invariable indication in **compound fractures** of the patella where amputation can be avoided (König, Lane). It is likewise the ideal method of treatment in simple transverse fracture (Cameron, 1877). Its application in individual cases will turn on the surgeon's knowledge and appreciation of the demands of a strict asepsis. The most brilliant result is obtained by a properly conducted operation for fracture of the patella; on the other hand, a most disastrous result may follow a slight lapse in the aseptic technic of the attempted procedure. A surgeon accustomed to rigid aseptic precautionary measures, with assistants trustworthy from the same standpoint, will undertake the operation with confidence. As stated by Stimson, "The general practitioner, and even the occasional surgeon, is not only fully justified in using a non-operative method, but ought to do so."

The question of **primary** or **immediate** suture is an important one. Rupture of the joint capsule other than at the site of the fracture, or **extensive**

contusion of the soft parts, or both, serve as a positive contraindication to primary suture. Rupture of the capsule, particularly at its upper recess (Riedel), permits ready infection of the intermuscular planes of connective tissue of the thigh; extensively contused soft parts, by lessening the local vital resistance, invite the occurrence of septic processes from slight causes. If, under the influence of an elastic bandage the effusion in the joint rapidly disappears, rupture of the capsule is to be suspected. Extensive contusions soon become manifest by extreme tenderness of the soft parts, ecchymosis, and infiltration. The operation, under these circumstances, must therefore be performed as an intermediate procedure, namely, after the lapse of ten days, or even longer, or when the contusions have greatly improved.

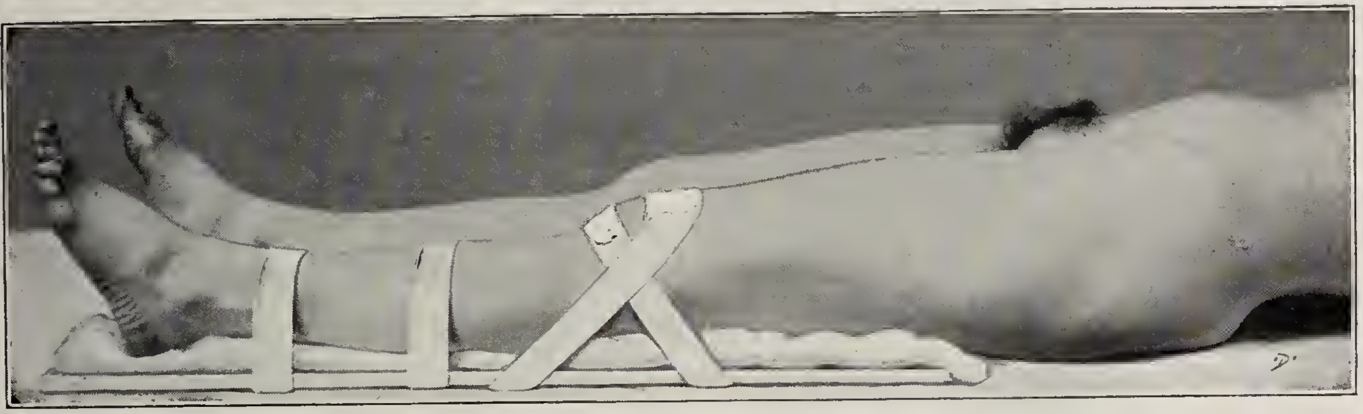

Fig. 802.—Dressings for Fracture of the Patella.

The technic of the operation consists in exposing the fragments by a laterally placed and slightly curved vertical (Fig. 804), or a U-shaped incision (Fig. 805) and tilting these so as to clear the fractured surfaces of shreds of fibrous tissue. If the fragments can be easily coaptated, **simple suture of the torn capsule and floor of the prepatellar bursa** will suffice (Fig. 804, B). In the great majority of cases this can be done. If **bone suture** is absolutely necessary, two holes are drilled in each fragment, the fragments approximated by forcing them together by means of a hooked retractor placed in each fragment, and **sutures of kangaroo tendon** passed and secured by tying (Fig. 805, B). The drill hole should start near the upper and lower borders of the bone and pass in an oblique direction so as to emerge on the posterior border at the line of fracture, but should not include the cartilaginous covering.

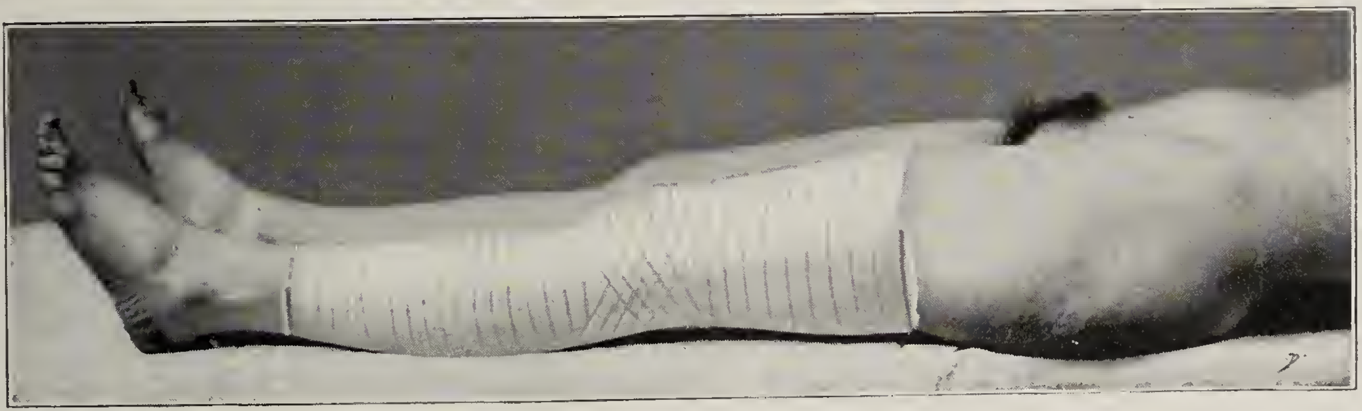

Fig. 803.—Method of Applying a Roller Bandage in Oblique Turns in Fracture of the Patella.

If, when **secondary suture** is attempted in old cases adhesions prevent approximation or hold the fragments in a tilted position, these should be loosened. Macewen recommended making V-shaped incisions in the quadriceps extensor to permit the upper fragment to be drawn down; Bergmann transplanted the tubercle of the tibia with the attachment of the ligamentum patellae in an upward direction in order to elevate the lower fragment. The first of these operations is an unjustifiably mutilating procedure and, even when successful, the risks which it occasions are not justified by the advantages gained. If the fragments will not come together without its aid, it is better to obtain the best approximation possible without it. The capsule is to be sutured, the skin wound closed, sterile dressings applied, and the limb supported on a back splint or a Volkmann posterior gutter-splint. In one case in which I resorted to Bergmann's device of upward transplantation of the tubercle of the tibia, the latter was torn loose eighteen months afterward by slight muscular effort.

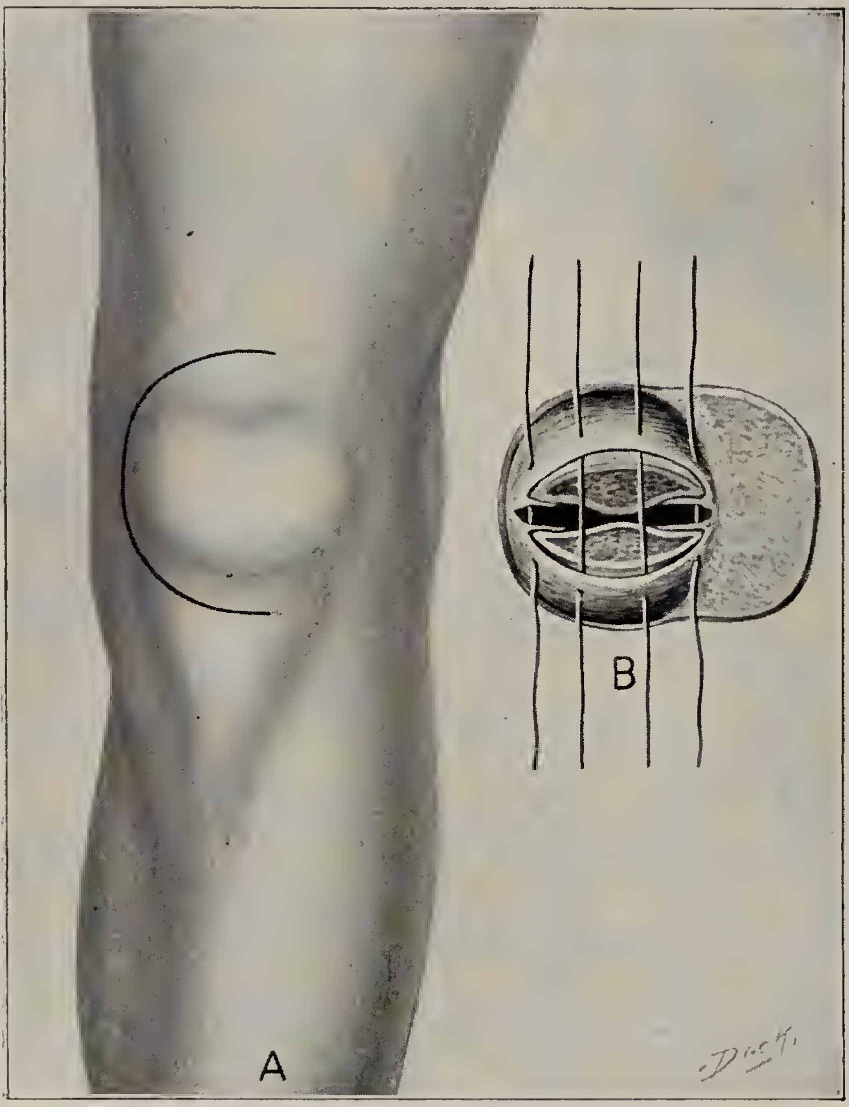

Fig. 804.—The Operation for Fracture of the Patella. A, The internal curved incision; B, sutures including only the capsule.

The splint is to be abandoned at the end of ten days, and, as soon thereafter as the skin wound is strongly healed, the patella **should be moved from side to side** once or twice daily to prevent the formation of adhesions (McBurney). The patient may walk about in three weeks at the most, the limb being supported on a back splint while he is up. This should be removed when he lies down. Some passive movements may be cautiously attempted from time to time after the first three weeks; these may be increased as time passes. To prevent refracture from an accidental fall, the patient may wear a "check" apparatus (Fig. 806).

The following points must be borne in mind: (1) The **fingers of the operator should not handle the parts,** but all manipulation must be carried out through the medium of instruments which can be sterilized. (2) Every incision must be a **clean cut;** there must be no blunt dissection. (3) **Retractors must not be allowed to bruise the parts retracted.** Blood-clots in the joint must be **wiped out** with gauze grasped in forceps; **irrigation must not be employed.** (4) The drilling of the bone and the use of a metal suture are to be avoided, if possible, as caries may result from this; **strictly aseptic kangaroo tendon,** or chromicized catgut, in the majority of cases, will prove an efficient substitute for silver wire, and **suture of the capsule alone will often suffice** to maintain approximation of the fragments. (5) The capsule should be sutured in any event, so as to secure early union at this point, and prevent infection of the joint should the devitalized soft parts exterior to the joint become infected. (6) Pressure of dressings on the wound must be avoided; tight bandaging that presses the soft parts hard against the patella will lay the foundation for sepsis in already devitalized structures.

Vertical or oblique fractures rarely give rise to displacement of the fragments. They may be treated with a posterior splint and the application of a bandage for about two weeks, when the splint is to be abandoned and passive movements combined with massage, to avoid ankylosis, cautiously commenced. In the rare cases of fracture of this class in which separation of the fragments occurs, non-operative methods should still be pursued, for the reason that there is no interposition of fibrous tissue, as a rule, and osseous union will take place. **Secondary suture** may be applied subsequently, if the disability is sufficiently great to demand it.

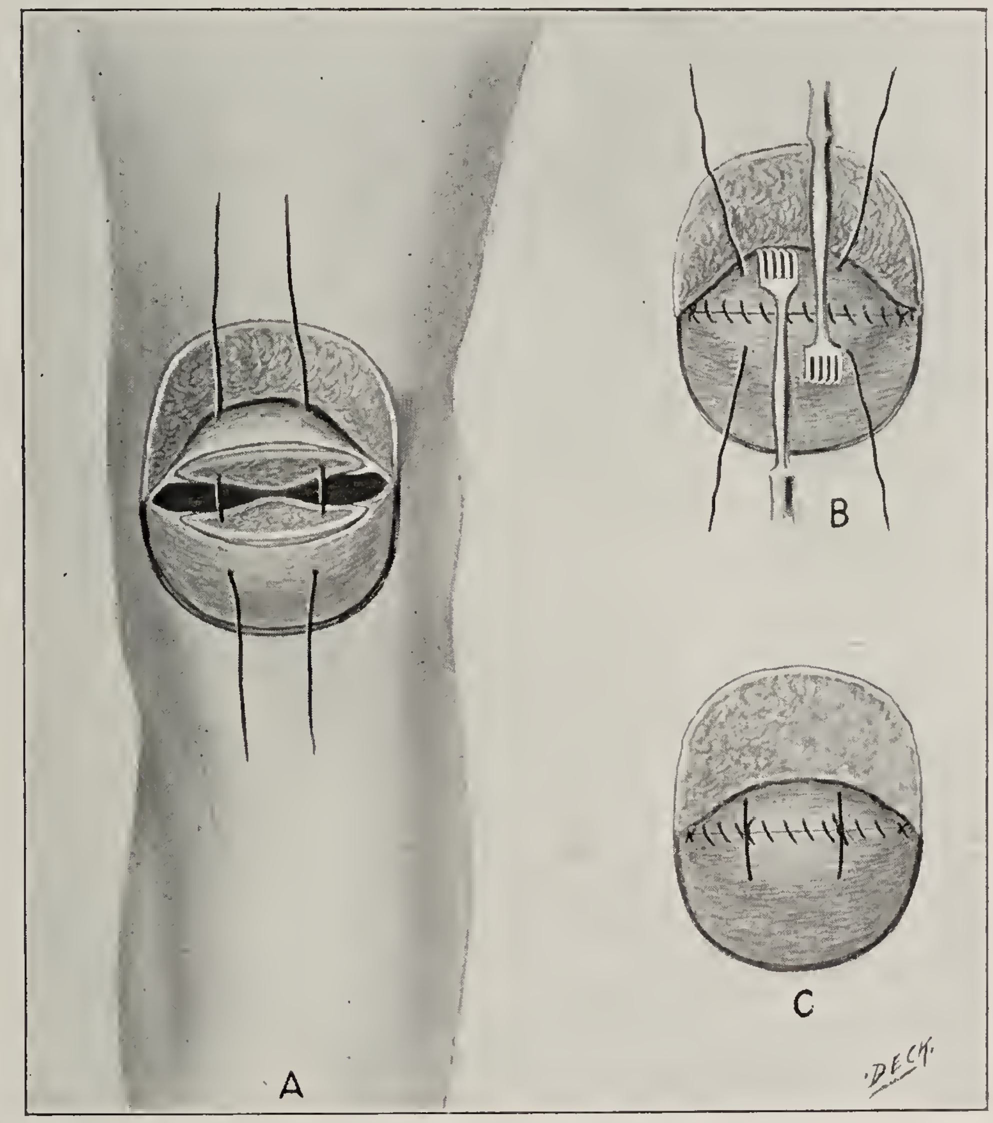

Fig. 805.—The Operation for Fracture of the Patella.
A, Bone sutures in place; B, retractors forcing together fragments while the capsule is sutured; C, bone sutures tied.

Rupture of the Ligamentum Patellae.—The patellar ligament, as well as the tendon of the quadriceps, may be ruptured. Either of these injuries may result from the same strain which, without the giving way of either one or the other of these structures, gives rise to fracture of the patella. Cases in which pieces of bone are torn off with the ligament or tendon and adhere to it, are transitory forms of fracture of the patella. Rupture of the ligamentum patellae is the more frequent of these accidents. It was described by Malgaigne as an upward dislocation of the patella. Rupture of the ligament, however, is the primary event, though the upward displacement is the important symptom.

The tibial insertion of the ligament, and sometimes a piece of the tuberosity of the tibia, are broken off. The ligament rarely gives way at the patellar insertion. Transverse separation in the middle of the ligament is still rarer, and is usually due to direct force. The mechanism is the same as in fracture of the patella. The great majority of the cases are due to muscular action. Rupture of both patellar ligaments has been reported (Gibson, Hamilton). In Lossen's case the ligament was ruptured by a charlatan in an attempt to flex forcibly a knee ankylosed in extension.

Rupture of the ligament is characterized by the upward displacement of the patella at least two fingerbreadths above the normal, the loss of the prominence of the knee and its replacement by a depression in the bottom of which may be felt, through the relaxed skin, the joint end of the femur and the anterior edges of the tibia. The torn band can usually be felt, as well as the space between the ends, which can be increased by flexing the leg. If the tuberosity is broken off, the fragment can be made out as a movable body. The presence of extravasation within the joint depends on the location of the rupture. If in the upper third, this will occur; otherwise not. The disturbances of function are the same as in fracture of the patella.

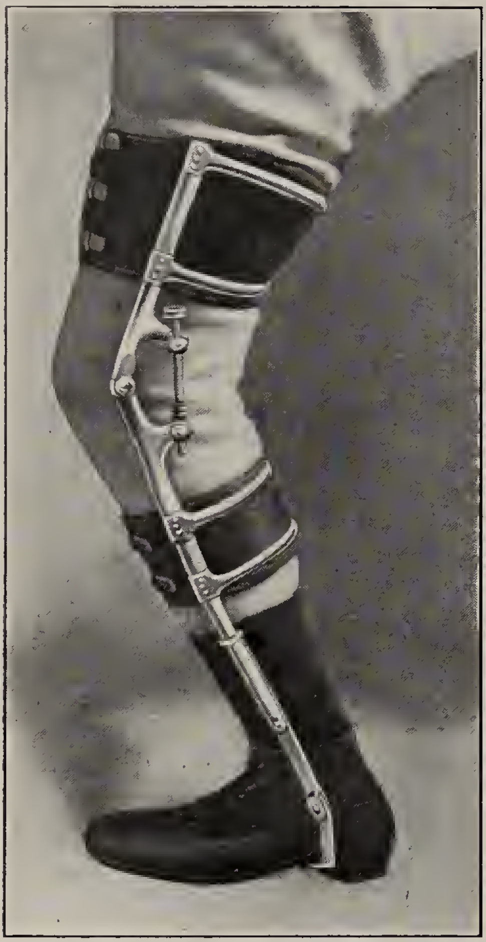

Fig. 808.—Brace for Fracture of the Patella.

The **diagnosis** is made by the upward displacement of the patella and its mobility, and the impossibility of extending the leg.

The **treatment** is that of rupture or fracture of the patella, namely, in the **non-operative treatment,** extension of the leg and flexion of the thigh on an inclined plane or posterior splint and adhesive plaster strips to draw the patella downward. The **operative treatment** consists in suture by fine silk or kangaroo tendon.

Rupture of the quadriceps tendon is still rarer. It has been erroneously called dislocation downward of the patella. Except when the result of direct force, it is due to sudden muscular action, usually an effort to save one's self from falling in making an unexpected step. Pain and inability to walk occur at once. A groove appears just above the upper edge of the patella, and the retracted stump can be felt. There is some extravasation surrounding the place of injury. If the patient attempts to extend the leg, some tension is made laterally between the fascia of the quadriceps and the leg, but complete extension is impossible. Flexion increases the space between the tendinous stump and the patella. The appearances are characteristic. The resilience of the patellar ligament impels the bone in a downward direction; the release from restraint of its upper margin permits this to tilt forward.

In the rare cases in which the tendon alone is involved in the rupture the hemorrhage may be slight, and the point of separation of the torn ends marked by a distinct gap through which can be felt the joint surfaces of the femur. If, however, as is usually the case, the tear involves the accessory extensors (the vasti muscles) together with the joint capsule, or the muscular portion of the rectus femoris, the hemorrhage is profuse. Under these circumstances the parts in the neighborhood of the injury become swollen and the gap between the torn ends obliterated.

The **non-operative treatment** is the same as for fracture of the patella, and rupture of the ligamentum patellae. The best functional results are obtained by suture.

Operation of Suture of the Quadriceps Extensor Femoris Tendon.—The site of the injury is exposed by a vertical incision extending from an inch above the rupture to the middle of the patella. The edges are retracted and the retracted tendon brought down and sutured by means of fine silk to the aponeurotic structures at the upper edge of the bone. The operation wound is sutured, dressed without drainage, and a plaster-of-Paris fixation dressing applied with the limb elevated. At the end of a month the patient may make cautious attempts at walking with the aid of crutches. Atrophy of the muscle should be treated with massage and electricity.

Fractures at the lower end of the femur implicating the knee-joint occur from falls on the flexed knee, blows from the kick of a horse, or the falling of a heavy body on the condyles. The fracture may be T-shaped or Y-shaped, the condyles being crowded apart. Madelung showed by experiments on the cadaver that this crowding of the condyles apart was the effect of a force applied against the patella. There is hemorrhage into the joint, the function of which is seriously threatened, **ankylosis, genu valgum,** and **genu varum** being the common sequences.

In **simple transverse fractures within the limits of the lower epiphysis** the lower fragment is displaced backward. This occurs partly from the action of the force inflicting the injury, and partly from the action of the gastrocnemius muscle.

Transverse separation at the lower epiphysial line is sometimes observed in children. It occurs from the same causes as those which produce fracture of the lower end of the femur in adults. It sometimes results from careless attempts to correct malpositions of the knee-joint by **brisement forcé.**

The **treatment** of simple fractures of the knee-joint and its neighborhood requires careful reduction, under an anesthetic, if necessary, and immobilization for from four to five weeks. The function of the joint must finally be restored by passive and active movements, massage, etc.

Injuries of the Soft Parts at the Knee.—Injuries of the popliteal artery and vein resemble those of the femoral vessels. **Rupture of the popliteal vessels** sometimes occurs as the result of forced movements. There is usually some preceding change in the walls of the vessels from endarteritis or an aneurism. **Typic ligation of the popliteal artery** is scarcely ever performed, the femoral artery being tied by preference.

The **prepatellar bursa** is exposed and liable to injury from a blow as well as to inflammatory conditions from fractures. Hemorrhage into the bursa will resemble the conditions present in chronic inflammations; it occurs much more rapidly, however. Slight pressure, an ice-bag, and massage will quickly remove the hematoma; a serous effusion will sometimes persist.

Acute Synovitis of the Knee-joint.—This has its origin in such injuries as contusions, and pressure on the capsule following intra-articular hemorrhages. These injuries are frequently produced by a fall on the knee, force applied from in front, lateral inflection with overstretching or rupture of a lateral ligament, usually the internal, and overexertion in walking. Slight serous synovitis sometimes follows the first efforts at walking after prolonged immobilization of the knee, as, for instance, in the treatment of hip-joint disease in which the comparatively rigid capsule is dragged on by forced tension until isolated portions are torn; the irritation produced leads to serous effusion (Volkmann).

Serous synovitis is sometimes ascribed to the influence of cold and dampness, the so-called **rheumatic synovitis.** In this class also belong the cases of **intermittent synovitis** in which a periodic return of the synovitis has been noticed. It has been supposed to bear some relation to malarial influences, but this has not been demonstrated. Quinin as an antiperiodic has been found to be useless in this affection.

In cases of synovitis the pain in the joint is experienced at first only on movement. In traumatic cases the pain is most severe at the point of injury. The entire joint becomes sensitive, however, and is hot and swollen. This may amount only to an obliteration of the furrow on each side of the patella; when considerable, the entire joint is increased in circumference and the oval space above the patella and behind the quadriceps extensor becomes prominent. The patella is lifted by the fluid; it "floats," so to speak. When driven back against the femur by a tapping movement, it strikes the latter with a click, and immediately rebounds.

The knee in mild cases with but slight effusion is in the position of extension; in more severe cases the presence of a considerable effusion in the joint compels a position of partial flexion. The affection is purely a local one; there is no general rise of temperature, but local heat is present.

Acute serous synovitis usually terminates in resolution and resorption of the effusion. The patient, however, is liable to have a recurrence on slight provocation, and this susceptibility may last for years. Suppuration rarely develops, but a chronic stage sometimes results in cases at first neglected. The serous effusion persists, though the pain and sensitiveness disappear. The effusion may even gradually increase, and a **hydrarthrosis** or **hydrops of the knee-joint** develop, which in time may lead, through tension on the ligaments and changes in the synovial membrane and the articular cartilages, to distortion of the joint, producing a **genu valgum** or **genu varum.** The synovial lining of the knee-joint, more than that of any other joint, is specially disposed to hyperplastic processes, and a condition similar to that present in **arthritis deformans** may follow acute synovitis.

Treatment of Serosynovitis of the Knee-joint.—Acute synovitis should be treated with the application of the **ice-bag,** or **ice-cold compresses,** and **rest.** Later the applications are replaced by **compression** by means of flannel or rubber bandages. Pressure of the bandages in the popliteal space is to be prevented by the application of a posterior splint well padded where it lies in this space, and the compressing bandage applied over the splint. When the tenderness subsides the convalescence is hastened by massage, alternated with warm bathing and active and passive movements. While fixation of the inflamed joint is necessary in the commencement, its usefulness has its limitations, and in the later stages, when the fluid is undergoing resorption moderate passive and finally active movements are advantageous; they may favor resorption, and prevent ankylosis from adhesions between the synovial folds.

Chronic serosynovitis is also best treated by compression. When the effusion is but slight, massage is useful.

In cases of **hydrops of the knee-joint** of long standing in which compression and massage have no influence on the effusion, the joint is to be punctured. If a clear serous fluid is present, the joint is to be irrigated with a 3 per cent solution of carbolic acid; if a serofibrinous or an opaque fluid is present, the joint is to be irrigated with a 1 : 1000 solution of corrosive sublimate (Schede). The after-treatment consists of the application of compression and fixation for fourteen days, and massage and passive movements afterward.

Papillary Synovitis.—This consists of localized hypertrophies of the synovial membrane, with the formation of so-called synovial fringes. These latter generally spring from the synovial membrane where the latter joins the cartilages; exceptionally there may be papillomatous growths extending over the entire synovial surface. These fringes or papillae consist of fibrous tissue, which, in cases in which these are long enough to become pinched between the articular surfaces, are covered with thickened synovial membrane. In some instances there is a marked deposit of fat in the fringes, constituting the condition known as "lipoma arborescens." The affection is comparatively common and is a frequent cause of chronic synovitis. It is not confined to the knee-joint, but has been observed in other joints as well. Its etiology is extremely obscure. By some it has been considered as dependent on the same causes as those from which rheumatoid arthritis results.

The **symptoms** of this condition are occasional **attacks of disability,** accompanied by **agonizing pain** and followed by **effusion into the joint,** and **tenderness on pressure.** The attacks may occur without special reference to the kind of movement at the time, and are due to pinching of the synovial fringes between the ends of the bones. When the effusion is not too great, particularly when the fringes occupy the lateral pouches of the joint, these may sometimes be felt on palpation, a sensation of soft crepitation being conveyed to the palpating finger as the fringes are moved about.

The **treatment** consists in dissecting away the fringes, particularly at the points where they may become pinched. The results of this treatment are promising where the dissection does not involve a large portion of the synovial membrane. The more of this latter that is removed, however, the more disturbance to the function of the joint follows. In cases of complete excision, fibrous ankylosis results. This, however, in a patient who is greatly crippled by the presence of this affection, is preferable to a condition involving both disability and excessive pain. In some cases improvement has followed evacuation of the effused fluid after an attack, and irrigation of the joint cavity with a mildly irritating fluid, such as a 2.5 per cent solution of carbolic acid or a 1 : 2000 solution of corrosive sublimate. The fibrinous effusion following the irrigation leads to adhesions and consequent fixation of the fringes to the surface of the synovial membrane, where less harm will result from their presence. A midway course of clipping away the more prominent fringes, those being selected which are in a position to become pinched, and then irrigating the joint and instituting drainage, is useful in cases where irrigation alone has failed. The limb is put up on a posterior splint for ten days, at the end of which time the drainage-tube is removed permanently, the splint abandoned, and passive movements made to avoid adhesions.

Free Bodies in the Knee=joint.—A loose body may be the result of an accident, a portion of the articular cartilage being detached from the underlying bone. These bodies usually develop, however, from embryonic cartilage cells in the synovial membrane and spring from some projecting fold of the latter, to which they remain attached by a delicate threadlike pedicle until some accidental movement results in tearing them loose. It would appear that they continue to increase in size, even after all organic connections with the synovial membrane have been severed.

The interference with the function of the joint varies according to whether the body has become severed or is attached by a long or short pedicle. When entirely detached, or if the pedicle is sufficiently long to permit considerable range of movement, it may become engaged between the joint surfaces and give rise to sudden attacks of agonizing pain and loss of function. The "locking" of the joint is complete for the time being, and after this has been relieved there may remain disability for a time, and more or less effusion into the joint. Even when the pedicle does not become sufficiently elongated to permit the loose body to be caught between the joint surfaces, there is usually more or less interference with the movements of the limb and effusion into the joint.

The **treatment** consists in removal of the loose body by **arthrotomy.** The body should be identified before the patient is anesthetized, for the reason that it occasionally slips to the posterior portion of the joint cavity behind the femur, in which situation it will be beyond the reach of the surgeon without an unjustifiable mutilation of the joint. The patient can usually identify and fix it in a position with the finger, after which the surgeon, after a preliminary infiltration cocainization of the skin overlying the loose body, transfixes the latter with a needle and thus secures it; or the patient's sterilized fingers may be utilized to hold the body securely while the surgeon removes it under cocain anesthesia. An incision is then made directly on the body, the capsule opened, and the loose body extracted by means of tenaculum forceps. If the opening in the capsule is large, it may be sutured separately and the skin wound closed. Usually, however, a suture or two in the skin suffices, or a strip of heat-sterilized adhesive plaster will answer the purpose.

The joint should be subjected to passive movements as soon as the wound has healed, in order to prevent the formation of adhesions. If care is taken during the operation to prevent the entrance of blood into the joint, troublesome adhesions are not likely to form.

Acute Infections of the Knee=joint.—The less severe forms of infections of the knee-joint, the catarrhal synovitis of Volkmann, are due to metastatic influences appearing in the course of general affections and often attacking more than one joint, such as acute rheumatism or **synovial polyarthritis;** less frequently in variola, scarlatina, typhoid fever, diphtheria, and erysipelas when this attacks the region about the knee. Similarly the knee-joint is attacked by **syphilis,** usually the congenital form, and the gonococcus of Neisser (**gonorrheal gonitis**). The gonococcus has been found in the pus from the joint in these cases by Petrone, Bristow, Kammerer, and others.

A condition of **abscess of the knee-joint** was described by Volkmann as occurring in children, attacking most frequently the knee-joint. A phlegmonous swelling of the knee-joint occurs, which points externally. A mucopus mixed with synovial fluid is discharged on incision, and recovery takes place with but slight interference, if any, with the functions of the joint.

Ordinary **acute suppuration** of the knee-joint is much more destructive than the forms above mentioned. The infection invades the joint from without through the fissure of an epiphysial fracture (see Gunshot Wounds of the Knee-joint), or an **acute infectious osteomyelitis,** a favorite seat of which is the posterior portion of the shaft of the femur, just above the knee. Fortunately this is not of frequent occurrence, for the reason that the posterior portion of the capsule does not include the epiphysial line and the epiphysial cartilage in young subjects assists in checking the extension of the inflammation. The fistulous openings following the discharge of the pus in these cases are situated at the outer edge of the vastus externus, or at the inner edge of the vastus internus. Sequestrotomy, therefore, can be carried out without invading the knee-joint.

Acute suppurative inflammation of the knee-joint is accompanied by fever, in this respect differing from the serous form. The swelling develops rapidly, and the tenderness is greater from the commencement. The patient places the joint in a position to give the most ease, flexing the limb at the hip and knee and abducting and rotating it.

Cases of suppurative inflammation of the knee-joint seldom recover without impairment of function. Even in the most favorable cases the adhesions which form between the synovial folds, together with the cicatricial contraction of the capsule, terminate in impaired mobility. In the cases that recover the severe forms of suppuration end in more or less complete ankylosis.

Chronic Inflammations of the Knee-joint.—Chronic suppurative inflammation of the knee-joint may persist after acute suppuration; it is most frequently due to **tuberculous arthritis** attacking the joint as either a **tuberculous synovitis** or a **tuberculous osteomyelitis.**

The knee-joint is more frequently attacked by tuberculous disease than any other joint in the body. This may be due in part to the large extent of the joint capsule, in part to the rapidity of growth in the bones forming the knee-joint, and in great measure to the exposed position of the joint to injuries, particularly in the young. The activity of the vascular apparatus at the epiphysial line favors to a great extent the deposit of infectious agents derived from the circulation at this point.

The disease is most frequently observed in the male sex (62 per cent in males; 38 per cent in females; Willemer of Göttingen). The first decade of life furnishes 44 per cent of the cases, and the second and third 28 per cent each. The affection originates in the bone in about 67 per cent of the cases (König). The **osteomyelitic focus** usually perforates into the joint; in the rare cases in which it follows an extracapsular course into the soft parts, this takes place from a focus in the tibia, where the capsule incloses only the most external portion of the epiphysis. In the majority of cases, this including more than half of those occurring in childhood, the affection begins as a **primary tuberculous synovitis,** with a later development of destructive changes and suppuration, or as a **serofibrinous synovitis** or **tuberculous hydrops articuli** (König), with miliary tuberculous deposits on the synovial surfaces. This form is not always easy of recognition in the commencement. It should always be suspected in cases of slightly painful synovial inflammation occurring in children.

Tuberculous inflammation of the knee-joint partakes of the usual characteristics of tuberculous joint disease elsewhere. This includes destructive lesions in the capsule, cartilage and bones, periarticular abscesses and fistulas, and, finally, destruction of the ligamentous structures; these serve to establish, on the basis of their appearance in the knee-joint, the typic clinical picture of tuberculosis of the joints in general.

The Clinical Course of Tuberculous Arthritis of the Knee-joint.—The clinical course of tuberculous arthritis of the knee-joint is essentially a chronic one in the great majority of cases. The onset of the affection is very insidious, as a rule, though exceptionally it may have a more acute commencement. The patient may show no symptoms other than a slight limp or an almost imperceptible dragging of the limb. There is a sense of fatigue, and some stiffness in the joint. The knee becomes gradually swollen, and some effusion may be made out by palpation, particularly in children, in whom, in the majority of cases, the affection commences as a tuberculous synovitis (König). In some cases the swelling is of a more solid or fungous character from the commencement, and in almost all instances it assumes this character later on. The swelling is more distinct than in other joints, for the reason that the capsule of the knee-joint is more superficially situated, and for the greater part is not covered by muscles. The skin assumes a tense and waxy appearance; there is no discoloration, hence the term **"white swelling."** In this stage of solid enlargement of the joint the pain on walking increases and the patient is soon compelled to walk with support or to assume the recumbent position. The joint becomes fixed, movements are impossible, and there is commencing flexion at the knee, which soon develops into a contracture unless this is prevented by proper fixation measures. As this, the second stage, advances, all the symptoms increase in severity. The swelling and pain become greater, the fixation and contracture more pronounced, and symptoms of suppuration, if they are not already present, make their appearance. There is more or less fever, loss of flesh and strength, failure of the appetite, and the general condition characteristic of tuberculosis. Disorganization of the joint advances, the capsule is perforated, periarticular abscesses form and find their way to the skin surface, and finally fistulas form. There is a certain noticeable attitude of the joint which occurs, namely, a flexion contracture, accompanied, in advanced cases and after destruction of the ligaments and erosion of the bony surfaces, by abduction, rotation outward, and subluxation backward of the tibia (Fig. 807).

Prognosis.—In tuberculous osteoarthritis of the knee-joint the prognosis is more unfavorable than that of any other disease of the joints, in respect to danger both to life and to function, not excepting the formerly much dreaded acute suppuration of the knee-joint. Children who are operated on for tuberculous caries only exceptionally attain manhood or womanhood, and rarely survive to reach old age. Billroth's studies revealed a general mortality of 42 per cent; Willemer, a mortality of 15 per cent in those under ten years of age, 39 per cent in those between ten and twenty years of age, and 45 per cent in those above twenty.

The disease may terminate at any stage in spontaneous healing, or a cure may result from treatment; on the other hand, the affection may be prolonged for years. Relapse may take place after apparent cure, even after the lapse of years; this is usually the result of an injury. Death may take place from general tuberculous infection, from tuberculosis of the lungs or of the intestines, from amyloid degeneration of the liver or kidneys, from progressive marasmus, or from intercurrent disease.

The Treatment of Suppurative and Tuberculous Inflammation of the Knee-joint.—Suppuration of the knee-joint, exclusive of that which occurs in connection with tuberculous disease, is to be treated by puncture and irrigation of the joint with an antiseptic solution. Should this fail the joint is to be incised **(arthrotomy)** and **methodic drainage** instituted. The first incision is made just in front of the external or the internal lateral ligament, with the fingers of the left hand pressing the pus over in this direction. The incision is enlarged to about one inch and a long and slender forceps passed beneath the patella to a point opposite, on which as a guide another incision is made. The tube is introduced by the forceps as these are withdrawn. The upper recess beneath the quadriceps is drained in the same manner. These methods of treatment refer particularly to the syphilitic, gonorrheal, and metastatic inflammations of the joint, and to those cases in which the suppuration is due to acute suppurative osteomyelitis (*vide supra*). In the last-mentioned class of cases even large sequestra of the femur and tibia may be

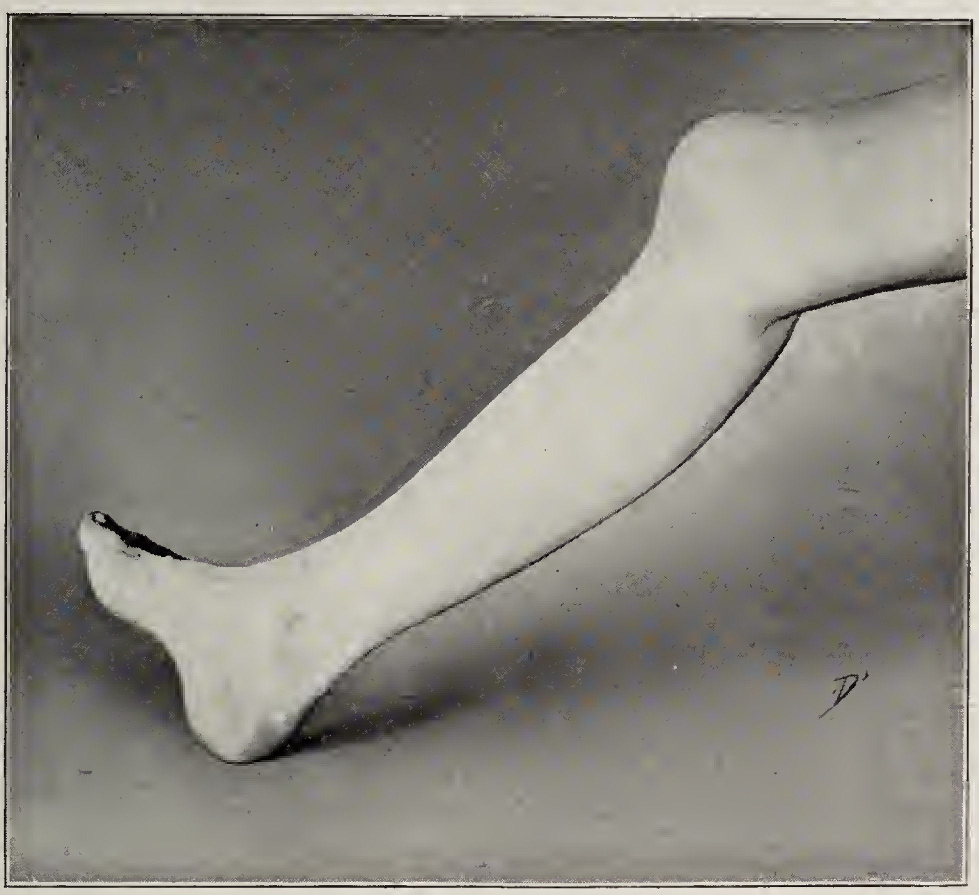

FIG. 807.—SUBLUXATION AND OUTWARD ROTATION IN DISEASE OF THE KNEE-JOINT.

present and extend into the joint and yet not give rise to the necessity for immediate resection, or amputation of the thigh. Antiseptic irrigation of the joint with a 3 to 5 per cent solution of zinc chlorid, a 1 : 1000 solution of corrosive sublimate, a 0.3 to 0.4 solution of salicylic acid, Thiersch's solution, or Bürow's solution of acetate of aluminum, followed by drainage, often effects marked improvement, and in some cases permits a subsequent successful sequestrotomy. Total suppuration of the joint with destruction of cartilage and erosion of bone is, in the case of adults, a positive indication for resection.

Treatment of Tuberculous Arthritis of the Knee.—Both local and constitutional measures are required in the treatment of tuberculous arthritis of the knee. The system must be fortified in the best possible manner for the struggle against the tubercle bacilli by a general strengthening plan of treatment, this including the administration of tonics, guaiacol carbonate, creasote carbonate, the use of brine baths at home and sea-bathing when available, residence in an equable climate and in elevated health resorts, and, above all things, an out-of-door life, good nourishing food, and pure air.

The **local treatment** consists in absolute rest, the application of plaster-of-Paris splints to prevent contractures, and the injection of 10 per cent sterilized iodoform glycerin. This remedy, in order to be of use, must be injected early; after the occurrence of suppuration it is practically useless.

In **intra-articular medication** the joint should be first tapped, its contents evacuated, and the iodoform glycerin forced into the joint cavity with a suitable syringe. In case the joint contents consist of broken-down tuberculous products which cannot pass out through the cannula, an incision is to be made on one side of the patella and the joint emptied and thoroughly curetted. The interior is then scoured with iodoform gauze, the incision sutured, and the injection made (Billroth). If pus has already commenced to form, pure carbolic acid may be advantageously substituted for the iodoform glycerin, carried to all the recesses of the joint after thorough curetment through a lateral opening made for the purpose, and finally washed away with 95 per cent alcohol (Phelps). The joint is to be drained by large glass tubes; copious sterile dressings are to be applied and the limb supported on a posterior splint.

When the iodoform glycerin is used, from two to four drams are to be injected every two to four weeks, according to the age of the child or the idiosyncrasy of the patient. After the injection the joint is to be manipulated and massaged lightly in order to distribute the fluid evenly in the joint.

With the occurrence of pronounced symptoms of suppuration the joint is to be opened, the pus evacuated, and total extirpation of the diseased synovial membrane (**synovectomy**), together with other diseased parts (**arthrectomy**), practised. The incision for the operation should be a transversely curved one from condyle to condyle, passing across the patellar ligament just below the lower edge of the patella (Fig. 810, B). The flap turned back includes the patella, and when the knee is flexed good access to the joint is obtained. The entire synovial membrane and diseased periarticular structures may now be dissected away and any diseased bone removed with the sharp spoon (**erasion**). Care should be taken not to remove bone that is simply softened from **osteoporosis**. The bone should be spared as much as possible, particularly in young children. All exposed surfaces are to be swabbed over with pure carbolic acid, which is allowed to remain in contact one minute, after which it is neutralized and washed away with 95 per cent alcohol. The surrounding skin should be protected from contact with the carbolic acid by gauze wet with alcohol. The flap is to be sutured except at the angles, where large rubber drainage-tubes emerge. The limb should be dressed in extension and maintained in this position in all stages of the disease and after any operative procedure.

Typic resection should be avoided in children as far as possible. Tuberculous foci in the bone should be followed up from the point where they have broken into the joint, with the chisel, gouge, or sharp spoon. The bone should in this manner be exposed at the site of any erosion of the cartilage. Bone cavities left by the removal of foci should be packed with iodoform gauze.

Amputation should be performed only as a last resort and for the preservation of life.

Inflammatory Contractures of the Knee-joint.—Contractures of the knee-joint of inflammatory origin are usually corrected without difficulty in the initial stage of the inflammation. Later on, when broad bands of adhesions have formed, these may require operative interference, should the correction not be effected by the application of moderate manual force. The treatment, therefore, must be largely preventive (*vide supra*). In all cases of disease of the knee-joint the position of the joint must be taken into careful consideration. A slight flexion when the healing process is completed in cases of anticipated ankylosis is the most useful position for walking. Should this exceed 5 degrees, it must be corrected by bandaging the joint to a splint, or by applying a plaster-of-Paris bandage after correction under anesthesia. In cases of rectangular flexion, Volkmann employed a weight and pulley extension, and vertical traction with the traction-band passed over the knee and through a hole in the mattress.

Flexions at an acute angle, formerly corrected by brisement forcé, are now, as a rule, considered proper cases for resection. Trial may be made, however, of the careful application of manual force after the anesthetic has been administered before proceeding to the resection. The dangers of fracture of the femur, and of injuries to the contents of the popliteal space, must be borne in mind.

Forced extension, or **brisement forcé,** is to be applied only under an anesthetic. If the contracture is an old one, and an attempt is to be made to overcome it by manual force, the following simple mechanic points are to be borne in mind:

Contractures of the knee-joint following inflammatory conditions are not caused simply by the shortening of the soft parts; only cicatricial, muscular, and congenital contractures are caused in this manner. In those having their origin in the joint itself, the **arthrogenous contractures,** there are extensive adhesions between the articular surfaces, the anterior as well as the posterior edge of the tibia being not infrequently adherent to the condyles of the femur in a malposition. These adhesions at the edges of the articular surface are, as a rule, more solid than elsewhere, for the reason that the capsule is here closely attached to the perisynovial tissue. The granulations on the articular surface following destruction of the cartilage become fused, and are surrounded by the dense fibrous ring of the thickened capsular attachments. If now the lower portion of the leg is grasped with the right hand, the left hand steadying the thigh, and the leg is forced in the direction of extension, a fixed point is established at the anterior portion of the attachment, the posterior portion being greatly stretched. Should this latter rupture, the tibia moves on the fixed point (Fig. 808, B). The dangers of this mechanism of correction of the flexion as they relate to the vessels posteriorly situated, as well as the pain following stretching of the nerve structures, are apparent at a glance. The weight of the body in walking tends to force the femur down in front of the tibia, causing pain in locomotion, and in time this incomplete dislocation may become complete. In cases where the posterior portion of the capsule refuses to yield the solid head of the tibia may be crushed into the spongy joint end of the femur (Fig. 808, C). Or the crushing effect may be exercised on the head of the tibia as well. It is probable that correction of a contracture with intra-articular adhesions is scarcely ever effected without either subluxation backward of the tibia or a crush fracture of the lower articular extremity of the femur or of the head of the tibia.

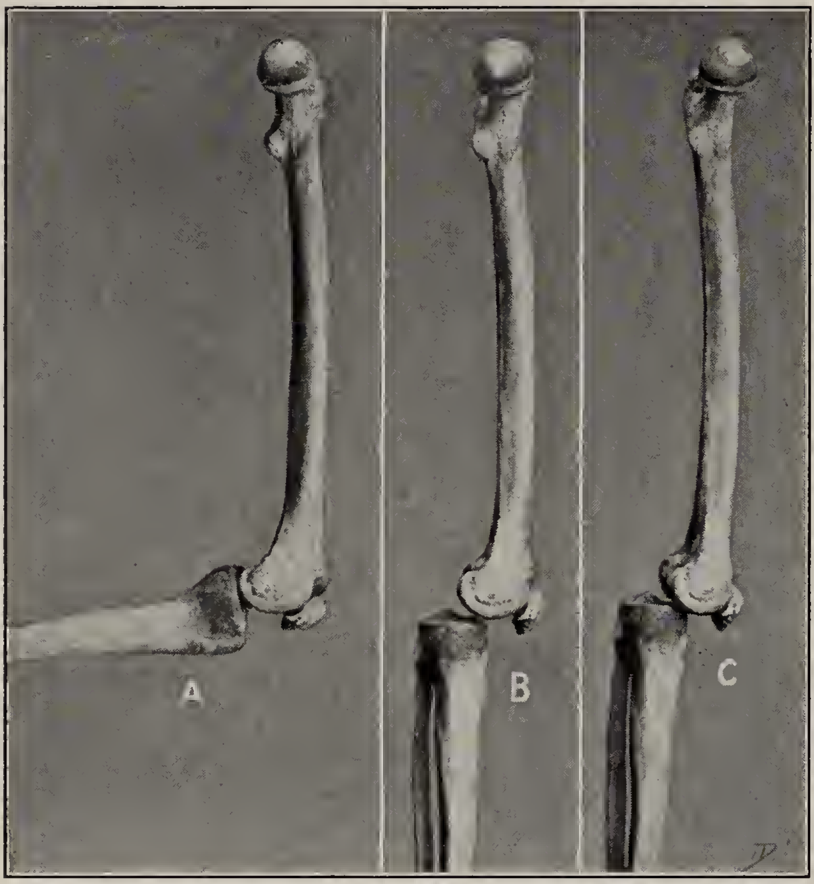

Fig. 808.—Schematic Representation of Forced Extension of Contracture of the Knee-joint.

A, Knee ankylosed in flexed position; B, the same straightened by force; C, tibia crushed into the spongy tissue of lower extremity of femur.

If the attempt is to be made the patient is placed on the abdomen, the leg grasped by the surgeon's right hand **just below the popliteal space,** the left pressing on the thigh firmly at its upper end. While the leverage is slight when the movement of extension is made, this may be compensated by leaning against the leg, while the hand grasping the leg at the popliteal space is employed in forcing the head of the tibia forward as the correction proceeds (Langenbeck). Besides overcoming the tendency to backward dislocation of the tibia, this method involves less danger of rupture of the popliteal vessels (Bardeleben). If, in spite of the pressure forward on the head of the tibia the latter is felt to rise under the hand and tend to backward displacement, there is much less risk in performing a resection than in persistent efforts to correct by brisement forcé.

If the effort to correct is successful, the limb is to be maintained in the proper position while a plaster-of-Paris bandage is applied. A fenestra is to be cut in the front to permit inspection and the application of an ice-bag if the reaction demands it. If some recurrence takes place, efforts to overcome this by apparatus should be made. It may be sufficient simply to apply a plaster-of-Paris dressing, cut away in front to correspond to the knee-joint, and to divide the splint transversely behind. As the flexion is overcome, pieces of cork are wedged into the space between the two halves of this behind from time to time until correction is obtained. The efficiency of this apparatus is greatly enhanced by the use of lateral rods attached to plates of perforated tin incorporated in the plaster (Billroth, Fig. 809). **Tenotomy** is to be resorted to only in cases in which it is plainly evident that the articular surfaces are free and that the flexor tendons are absolutely and indubitably a bar to correction; this is a very rare circumstance. The operation, therefore, is considered as fulfilling but few indications, in modern times, for the reason that the contracture is not essentially due to shortening caused by nutritive changes in the flexor muscles, but rather to adhesions of the synovial and perisynovial tissues and articular surfaces. Forcible extension under an anesthetic and consequent stretching of the shortened tendons are now substituted for tenotomy in the majority of cases.

Tenotomy in Contractures of the Knee-joint.—The tendons to be divided are those of the biceps flexor cruris and the semitendinosus and semimembranosus. The biceps, or outer hamstring tendon, can be very easily made out on the outer margin of the popliteal space. The only structure in the neighborhood likely to be injured is the peroneal nerve, which lies along its inner border. If the open method of division is adopted, the nerve may be easily isolated and avoided. The inner hamstring tendons requiring division are those of the semitendinosus and semimembranosus. The former is the nearer of the two to the median line of the limb, and is more superficially situated than the latter. It may be felt as a distinct cordlike structure. The tendon of the semimembranosus lies just to the side of the internal condyle, that of the semitendinosus between this and the gracilis. It is the most deeply placed of the hamstring tendons, and is of large size.

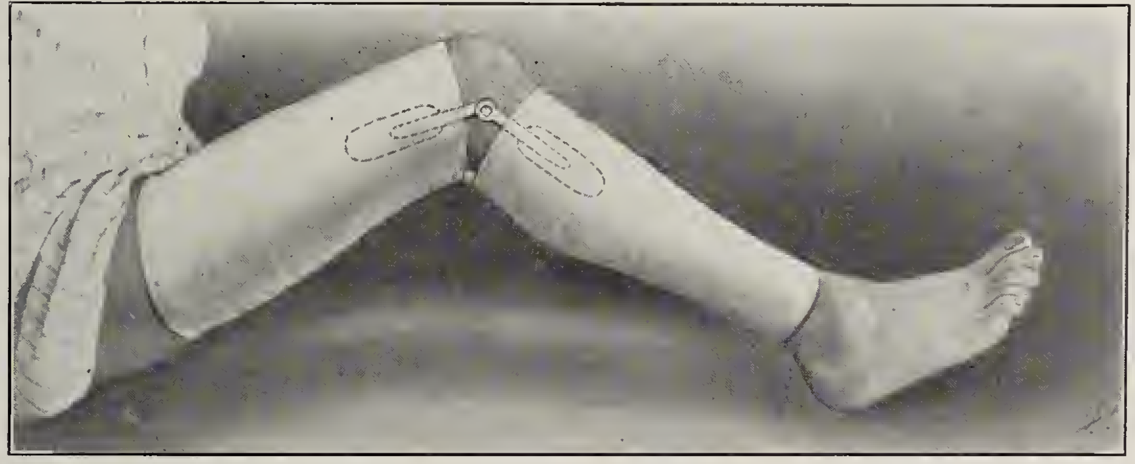

Fig. 809.—Billroth's Apparatus for the Gradual Correction of Contracture of the Knee-joint.

The Operative Treatment of Ankylosis of the Knee-joint.—If the attempt to overcome flexion at the knee-joint with firm fixation of the joint structures, either by bony or by extensive cartilaginous attachments fails, operative measures must be resorted to.

Ankylosis of the patella is an occasional source of obstruction to correction, though rarely the sole cause. Maunder corrected this by introducing a tenotome at the edges of the patella and dividing the adhesions. Hueter effected the same object by chiseling the bone loose.

Subcutaneous linear osteotomy, somewhat after the manner of Macewen's procedure for the correction of genu valgum (see page 579), has been employed for ankylosis of the knee-joint in flexion. The section is made in such a manner as to weaken the bone transversely about three inches above the condyles, after which the correction is made by partial fracture (Langenbeck). For slight degrees of flexion this operation is applicable, but in the great majority of cases it will be necessary to remove a wedge-shaped piece from the femur (**supracondyloid cuneiform osteotomy**).

Cuneiform Resection of the Knee-joint.—The method most favored by surgeons at the present day is the removal of a wedge-shaped piece of bone from the femur (Rhea Barton) or tibia, or both (Gurdon Buck), corresponding to the angle of flexion, after which the bone surfaces are brought into apposition. The operation is performed through the lower curved incision extending from one condyle to the other (*vide infra*).

Resection of the Knee-joint.—Typic resection of the knee-joint has been largely replaced, particularly in children, by simple excision of the diseased synovial membrane (**synovectomy**). But it must be said that, in the case of adults at least, it is better to remove the joint surfaces in order to identify possible foci in the bone substance, since it has been shown that, with the exception of cases occurring in early childhood, in the great majority of instances the disease commences in the bone. The surgeon will be justified, however, in substituting synovectomy with **atypic resection** for typic resection in children, even if a subsequent operation becomes necessary; first, because in at least half of the cases occurring in children, the disease commences in the synovial membrane, and, second, for the reason that injury to the epiphysial cartilage in younger life results in disturbances of growth dependent thereon. An increased amount of care is necessary in the after-treatment, however, following synovectomy, to prevent contracture from taking place, as the tendency to this is much greater than after typic resection. The absence of shortening and the possibility of securing some motion in the joint are to be placed to the credit of synovectomy.

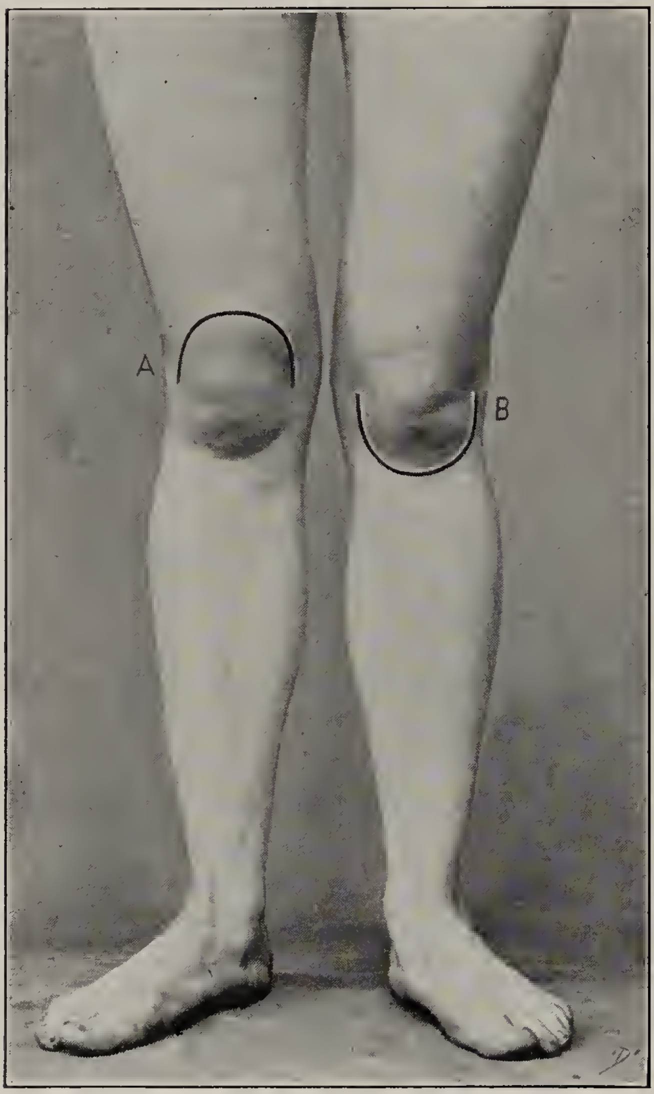

Fig. 810.—The Incisions in Resection of the Knee-joint.
A, Hahn's upper curved incision; B, the lower curved incision.

The best incision for resection of the knee-joint is that known as the **lower curved incision through the ligamentum patellae.** The knee is to be flexed to a right angle. The incision commences at one condyle, is curved gently downward and forward, crosses the front just below the lower extremity of the patella, and thence curves backward and upward on the opposite side to the other condyle (Fig. 810, B). The lateral portions of the incision should be limited to the space between the origin and insertion of the lateral ligaments, to avoid injury to the articular arteries (J. D. Bryant). The first cut divides the skin, the patellar ligament and the capsule. The knee is forcibly flexed and both the lateral ligaments and the crucial ligaments are divided; the curved flap containing the patella is turned upward. The joint is now accessible in all its parts, and the capsule is dissected out *in toto*. The upper prolongation of the capsule beneath the quadriceps extensor, and the posterior portion in the direction of the popliteal space must be carefully excised, in effecting which care must be taken to avoid injury to the popliteal artery. The operation thus far described is that of simple synovectomy. The further steps of the operation will depend on circumstances.

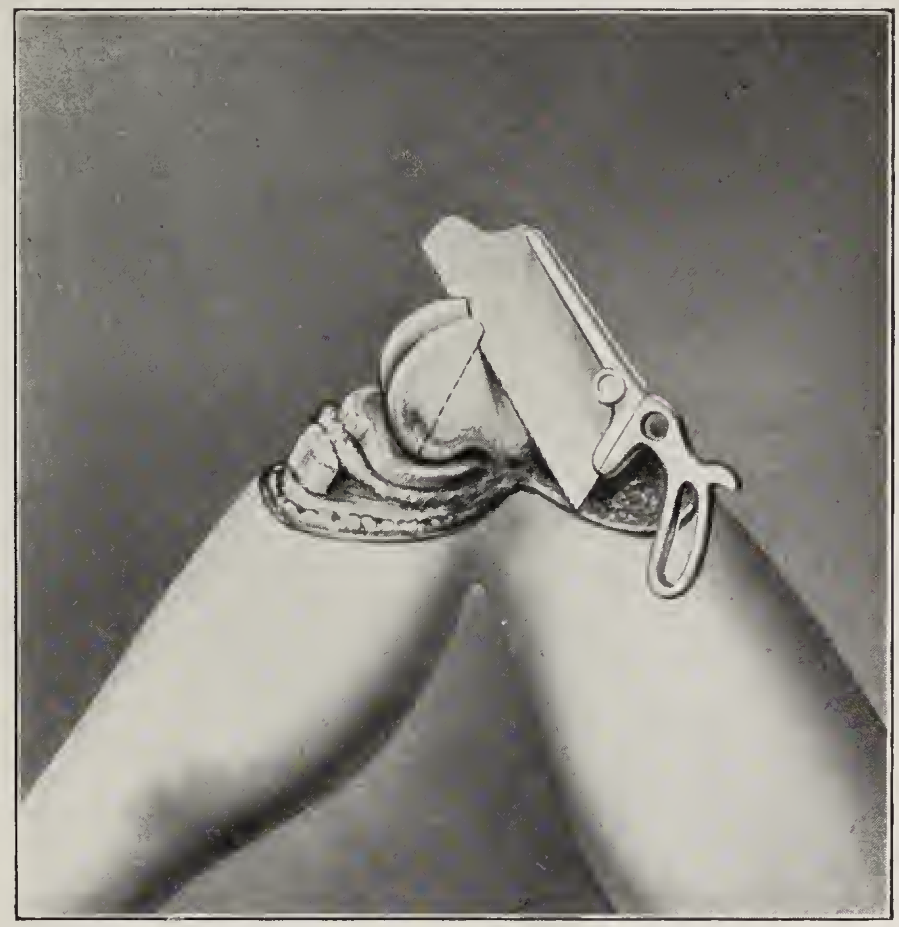

Fig. 811.—Resection of the Knee-joint. Removal of the articular surface of the femur in resection of the knee-joint.

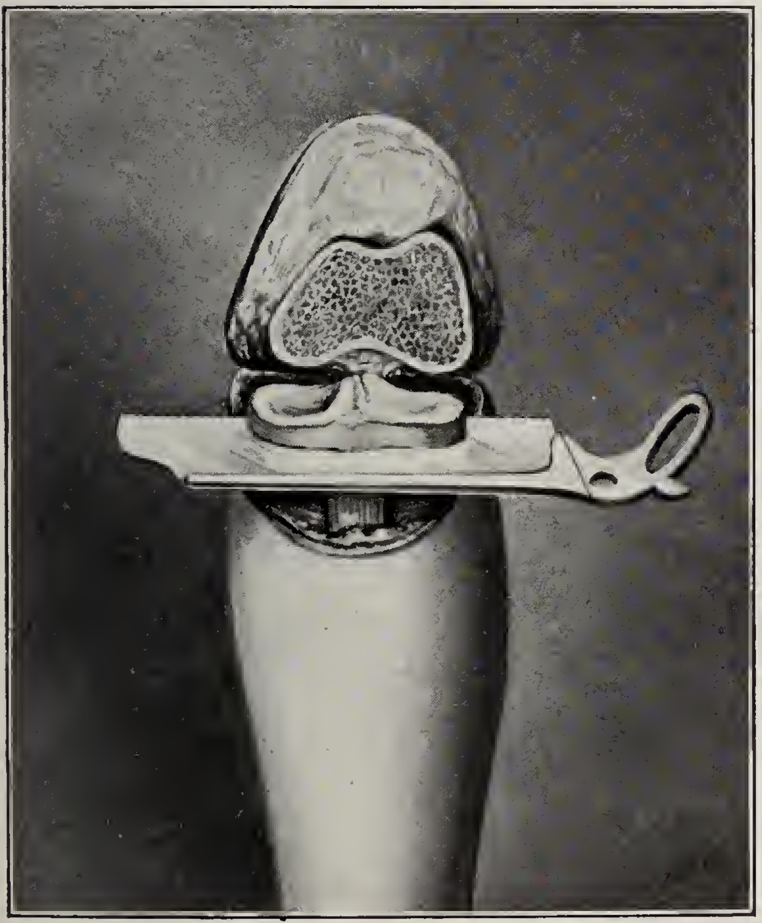

Fig. 812.—Resection of the Knee-joint. Removal of the articular surface of the tibia.

Typic resection consists in the removal of both articular surfaces, *i. e.*, the femur and the tibia (Fig. 812). The patella is likewise removed, though it may not be diseased, since its hard surface beneath the flap will endanger the vitality of the latter in case it becomes needful to bandage the parts rather tightly afterward in order to arrest oozing, a necessity which frequently arises. Its retention adds nothing to the usefulness of the limb in typic resection. The sawed surfaces are to be critically examined for traces of tuberculous foci and all suspicious portions are to be scooped out with the Volkmann sharp spoon. Simple softening from **rarefying ostitis** in the neighborhood of foci does not require removal. The cavities remaining after the tuberculous foci are curetted out should be packed with iodoform gauze with the ends projecting at the angles. In order to lead these strips out from the cavities in the bone and at the same time to permit their ready removal, a groove should be chiseled out of the cortical substance at each lateral edge of the sawed surface of the femur, through which the strips are passed. The sawed surfaces are to be accurately approximated in order to secure bony union of their surfaces (**synostosis**), and the external wound closed with interrupted sutures. No sutures, pegs, or nails are necessary to secure the bones in apposition; these are liable to induce caries by their presence. The parts are supported with copious dressings of gauze and a Volkmann posterior splint.

The **upper curved incision** of Hahn (Fig. 810, A) is the reverse of the one just described. It passes from one condyle to the other and embraces the tendon of the quadriceps just above the patella. It gives excellent access to the joint, particularly at its upper recess. After the joint is opened the flap is reflected downward.

In very rare cases **amputation of the thigh** is indicated in contractures and ankylosis. This, however, will scarcely ever be resorted to except in cases of violent neuralgic pains which are not relieved by resection, and in cases in which one of the unfortunate accidents already referred to in connection with the employment of brisement forcé makes it necessary.

The Functional Results of Resection of the Knee-joint.—While in the case of all other joints a **nearthrosis** or movable articulation replacing the one removed is aimed at, immobility is the ideal result after resection of the knee-joint, so that a proper and natural support for the body may be obtained (Park). The shortening present, which, in the majority of cases, is not great, is readily compensated for by an extra thickness of the sole of the corresponding shoe; even without this, in many cases, a scarcely perceptible limp is present after a time, on account of the lateral tilting of the pelvis. Experience shows that, even in young children, if only a very thin slice of bone is removed, particularly in the case of the tibial epiphysis, the restriction of growth is not very great. Unfortunately, however, the epiphysial line of the femur at least is almost always encroached on, owing to the extent of the disease. Eulenburg reported several cases of paralysis due to angulation of the tibial nerve in the coaptation of the sawed surfaces. Heinke demonstrated at autopsy in one case that the paralysis depended on the involvement of the nerve in the surrounding cicatricial tissue. H. Braun was compelled to amputate in a case in which the sawed surface of the tibia projected backward and made pressure on the popliteal nerve. In a second case in which the same displacement was present this did not occur; the displacement was shown to exist by a subsequent amputation on account of recurrence of the tuberculous disease.

Cicatricial, Myopathic, and Neuropathic Contractures of the Knee.—Cases of contracture of the knee other than those due to inflammatory affections of the joint are due to **pathologic changes in the soft parts.** Of these, the most common are **contractures of cicatricial tissue** at the site of skin defects following burns or other injuries of the soft parts on the posterior aspect of the knee. These are difficult to prevent for the reason that, in spite of the greatest care in the application of posterior splints and retentive bandages during the healing process, and the use of skin-grafting, an intrinsic tendency to contract exists in the deep scar tissue, even after the repair is complete.

The difficulties in overcoming cicatricial contracture are considerable. The tendons of the hamstring muscles become attached to the cicatrix and the latter often ruptures in attempts to extend the limb. This is followed by ulceration, which, on healing, reproduces the contracture. Gradual extension by means of the divided plaster-of-Paris splint of Billroth (see Inflammatory Contractures of the Knee-joint, page 573) is sometimes successful in cases in which the contracture is not great. Moderate extension may be obtained under an anesthetic, after which gradual extension is to be carried out.

Contractures approaching a right angle are best treated at first by a weight and pulley extension. Dissecting out the entire cicatrix, with tenotomy, if necessary, and filling in the defect with a skin flap may be tried if the scar tissue is not too extensive. In cicatrices covering a large area, division of the latter in several places and filling in the defects with skin flaps should be tried. To prevent recontracture during healing, the extremity may be laid across the other and the two secured by plaster-of-Paris bandages (Czerny). Relapses are likely to occur after any or all of these operations if the scar tissue is both deep and extensive. As a last resort, in cases of an otherwise useless limb, **resection of the knee-joint,** combined with skin-grafting and tenotomy, should be given a trial before resorting to amputation.

Myopathic contractures and **neuropathic contractures** result from primary disease of the muscles and nervous system. The first named are extremely rare at the knee-joint. The neuropathic contractures are, first, **spastic contractures** arising in the course of spastic spinal paralysis, and characterized by muscular spasms and exaggerated reflex action; second, **paralytic contractures** due to injury or disease of the central nervous system and the peripheral nerves. **Infantile paralysis** is a frequent cause of contractures of this nature in the lower extremity, but these contractures occur more frequently at the ankle than at the knee. They arise partly from the unopposed action of the healthy muscles, and partly from the weight of the body and the limb itself. Their surgical treatment consists of supporting apparatus for the prevention of deformities or for their correction, aided by **tenotomy,** or by excision of a portion of tendon (Lorenz) when necessary, and, finally, by the formation of an artificial ankylosis (**arthrodesis**). The ankylosis is brought about by typic resection of the articular surfaces and bony union. **Neurectomy** of the obturator nerve has been performed for adduction spasm.

The further treatment of infantile paralysis consists in the use of the galvanic and faradic current and massage. Spastic rigidity is treated by passive exercise, galvanization of the cord, and counter-irritation along the spine.

Curvatures at the Knee.—There are two curvatures at the knee of surgical importance, the one occurring in abduction and the other in adduction.

Genu valgum, or **knock-knee,** is a curvature in abduction and is usually combined with hyperextension and outward rotation of the leg (Fig. 813). It is caused essentially by the weight of the body, and occurs in rachitic subjects. It is most frequently observed in children shortly after they have learned to walk, and may be so slight as scarcely to attract notice. In cases occurring at about the age of puberty the subjects either have been rachitic in childhood, or are suffering from a late form of rachitis. It is most often met with in those whose occupation requires long-continued standing, such as bakers, waiters, etc. The deformity commences with an inward curve of the lower part of the shaft of the femur due to rachitic softening, and the weight of the body in walking or standing. The line which represents the direction in which the weight of the body is transferred to the ground in standing, and which passes from the top of the head of the femur through the knee and ankle under normal conditions, in genu valgum passes outside the knee. The result of the bending is to increase the normal slight obliquity of the articular surfaces in an outward direction; the weight of the body rests more and more on the external condyle, and the internal condyle is correspondingly released from pressure. The effect of this is a disproportion in the growth of the two condyles; the inner condyle becomes longer, and the outer one shorter. In advanced cases similar changes may take place in the tibia.

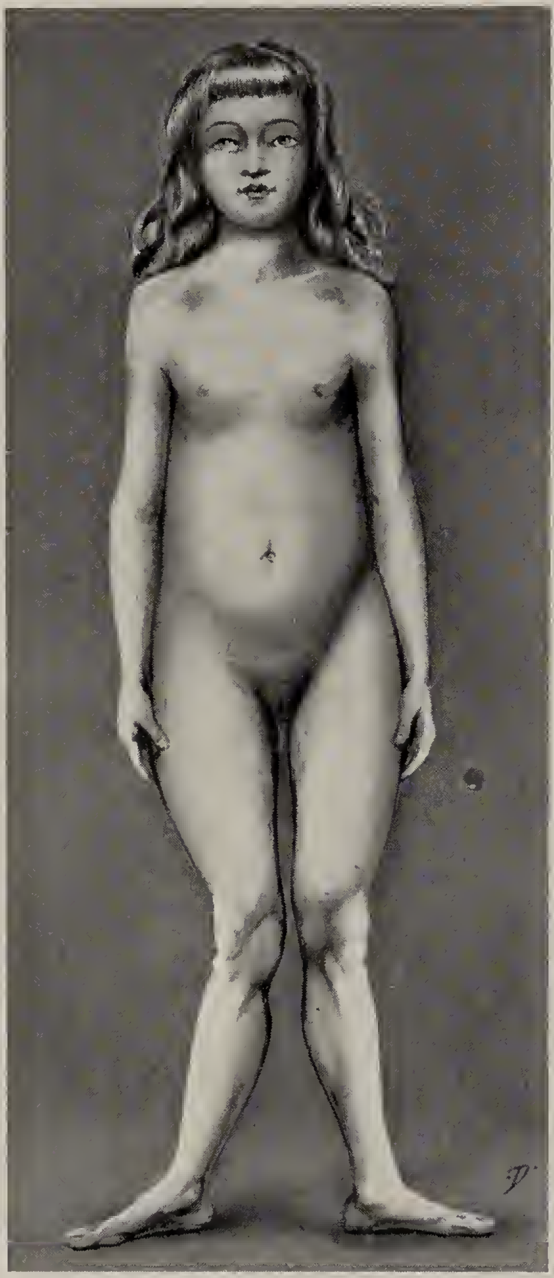
Fig. 813.—Double Genu Valgum.

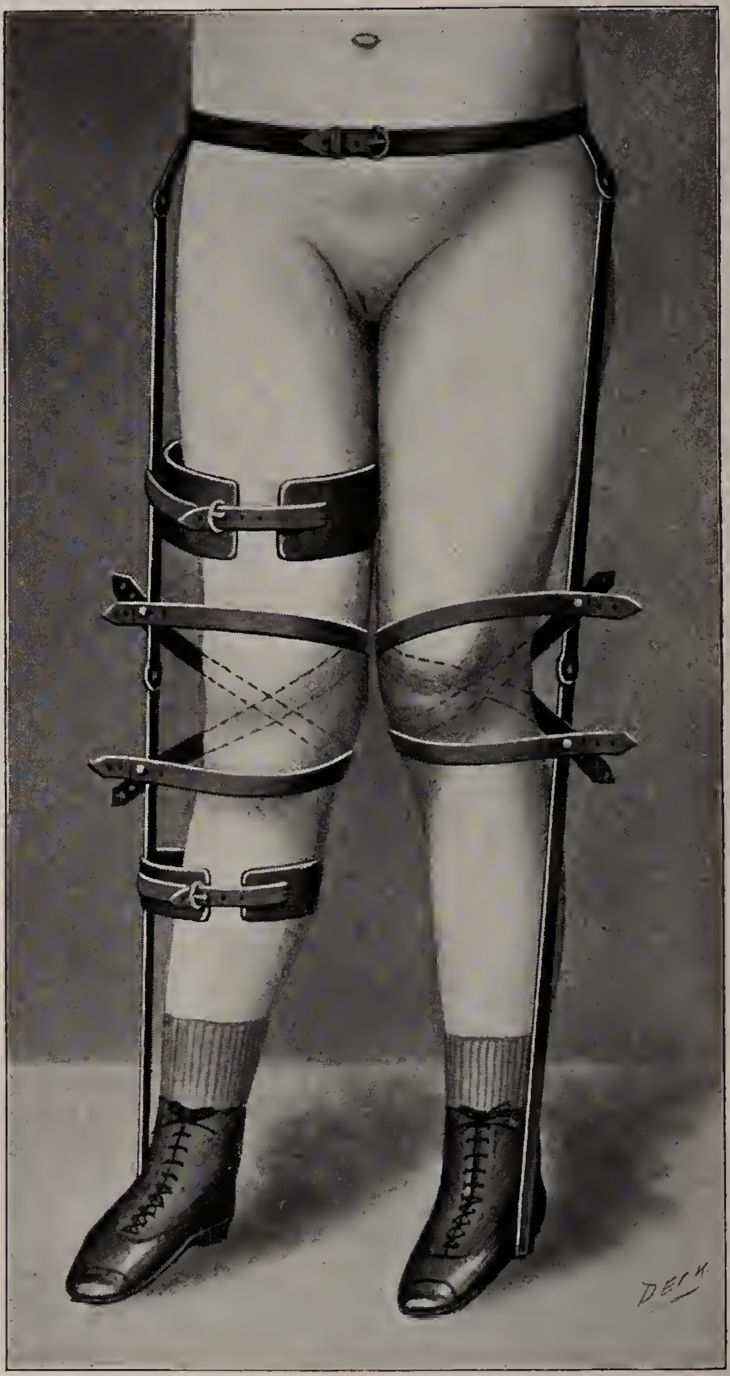
Fig. 814.—Genu Valgum, Showing Tiemann's Brace Applied.

Treatment.—Slight cases of genu valgum in children may be treated by a simple brace jointed at the knee and attached to the shoe and to an encircling band at the thigh (Fig. 814). The knee is to be drawn toward this by a knee-cap placed over the inner condyle. In advanced cases and in adults Mikulicz's plaster-of-Paris splints with elastic traction are useful. Two hinged plates are incorporated in plaster splints above and below the knee. The splint is first applied in one piece; it is then cut away as shown in Fig. 815. An elastic cord is attached to two hooks, one of which is incorporated in the upper end of the splint, the other in the lower segment. **Wolff's method** consists of forced **correction** in several sittings. The patient is anesthetized and a plaster-of-Paris splint applied from the malleoli to the trochanter; before it hardens the leg is straightened as much as possible. After a few days the splint is divided, as in Mikulicz's method, and further correction obtained by wedge-shaped pieces of cork. Or the hooks and elastic band may be applied. The forcible correction is repeated every few days.

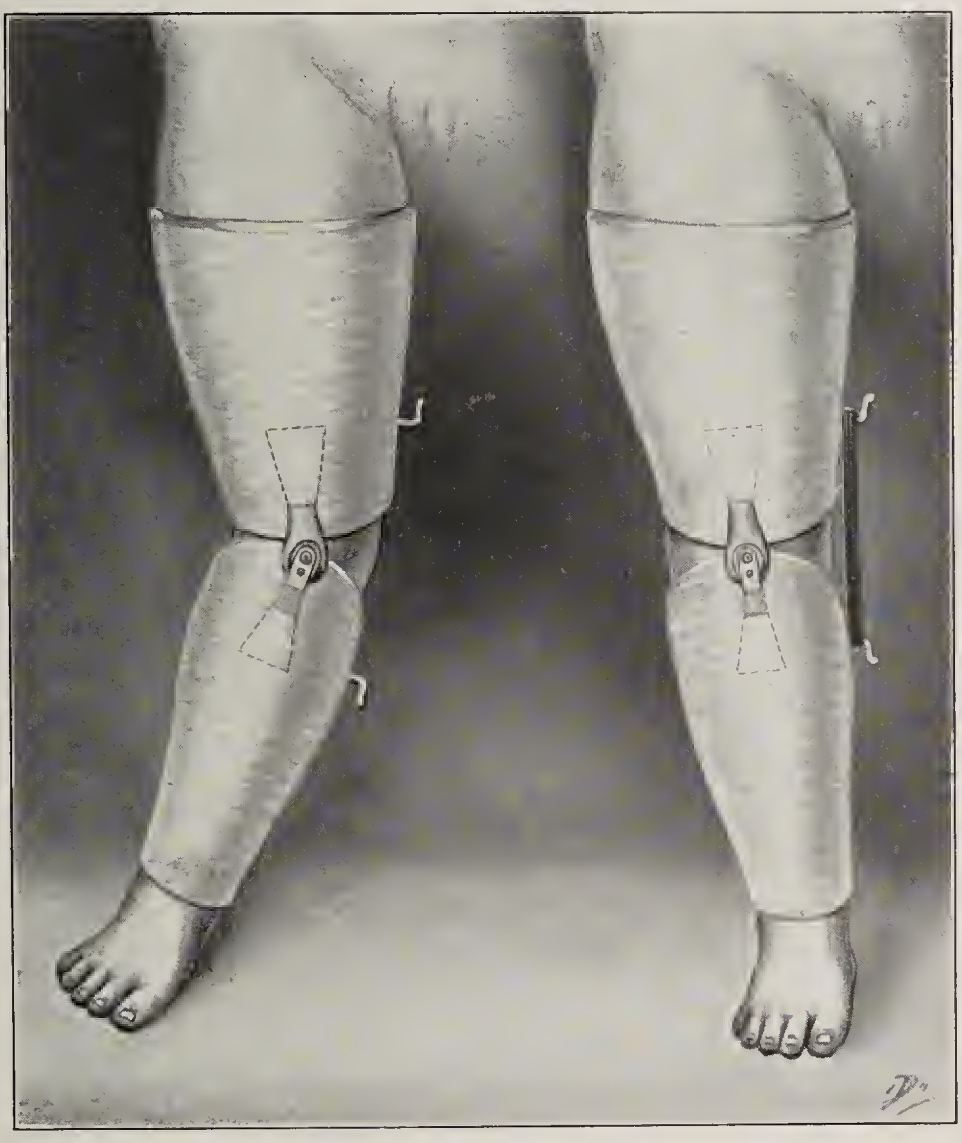

FIG. 815.—MIKULICZ APPARATUS FOR GENU VALGUM.

Operative treatment consists in performing a linear osteotomy above the condyles, or supracondyloid osteotomy (Macewen). A small incision is made just above the adductor tubercle of the femur, and the bone chiseled across for about two-thirds of its diameter (Fig. 816). This weakens the bone at this point, when it is easily broken and straightened. An antiseptic dressing and a plaster-of-Paris splint, or a posterior and an external lateral splint with their edges nailed together (L-shaped on section), complete the dressing. Healing takes place in from four to six weeks. When the tibia is at fault, a cuneiform osteotomy of this bone may be performed.

Genu varum, one of the forms of bow-legs, is a curvature in adduction. It is the opposite of knock-knee, and also depends on the rachitic diathesis.

It is almost entirely confined to children. The curvature occurs at the lower portion of the shaft of the femur, and below the epiphysis of the tibia. In mild cases it may be cured by **orthopedic apparatus**; in severe cases it will be necessary to interfere operatively, either by fracture with the osteoclast (**osteoclasis,** Lorenz) or by linear osteotomy. Cuneiform osteotomy is necessary only in advanced cases, or in adults. The operation is usually performed on the tibia; the fibula is also broken, if necessary. The correction is maintained by a plaster-of-Paris splint.

Diseases of the Bursae in the Region of the Knee.—The bursae and synovial sheaths of the tendons in the vicinity of the knee-joint may be attacked with the same inflammatory conditions observed in the synovial membrane of the joints.

Prepatellar bursitis is an inflammation of the bursa which lies on the anterior surface of the patella (Fig. 817). In the acute form it may be serous, hyperplastic (serofibrinous), or suppurative. There is a circumscribed and fluctuating swelling corresponding to the site of the patella. The suppurative inflammation sometimes assumes a phlegmonous character and extends to the surrounding connective tissue.

In the chronic form, or **chronic prepatellar bursitis (prepatellar hygroma),** there is a painless circumscribed swelling with a covering of normal skin. Its contents are a mucous fluid of varying consistency. In old cases the walls are thickened, frequently calcified, and lined with vascular villi. They often contain free bodies which are made up of amorphous fibrin concretions resembling melon-seeds or rice grains (**corpora oryzoidea**). These bodies have their origin in rupture of the pedicles of the villi and their detachment. A large number of these may be present and palpable from without. A myxoma in the patellar region may develop from a hygroma. As the result of injury hemorrhage may occur within either the diseased or the healthy bursae (**prepatellar hematoma**).

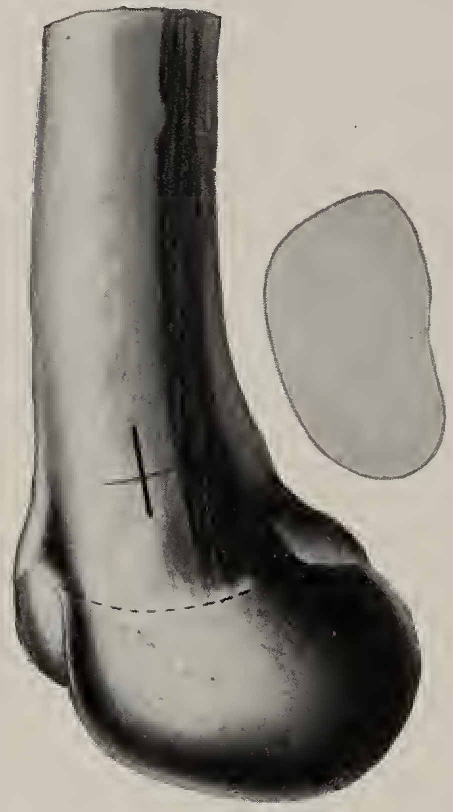

FIG. 816.—THE SUPRACONDYLOID OPERATION FOR GENU VALGUM (AFTER MACEWEN).

The heavy longitudinal line represents the seat of the incision in the soft parts; the light transverse line shows the position of the osteotomy. The smaller figure is an outline of a transverse section of the femur at the seat of operation.

Prepatellar hygromas are usually due to mechanic causes, such as pressure and irritation, and are found particularly in those who work on their knees, as in scrubbing floors, etc., hence this disease is sometimes called **"housemaid's knee"** (Fig. 818). It may be tuberculous or syphilitic. The chronic form may become acutely inflamed at any time, and suppuration occur.

Treatment.—The serous and hyperplastic forms are best treated in the beginning by means of a plaster-of-Paris bandage, with a thick padding of cotton over the inflamed parts (Fig. 819). Later on the parts should be strapped with mercurial plaster. If distention with fluid persists, elastic compression should be tried. If this fails, or if suppuration ensues, the bursa should be incised freely, curetted, irrigated with a 1:1000 sublimate solution, and packed with sterile gauze wrung out of hydrogen dioxid, and a wet antiseptic dressing should be applied over this. If loose bodies are present, or if chronic thickening results from the inflammation, the bursa should be excised. In tuberculous and syphilitic bursitis, the bursal sac is to be excised.

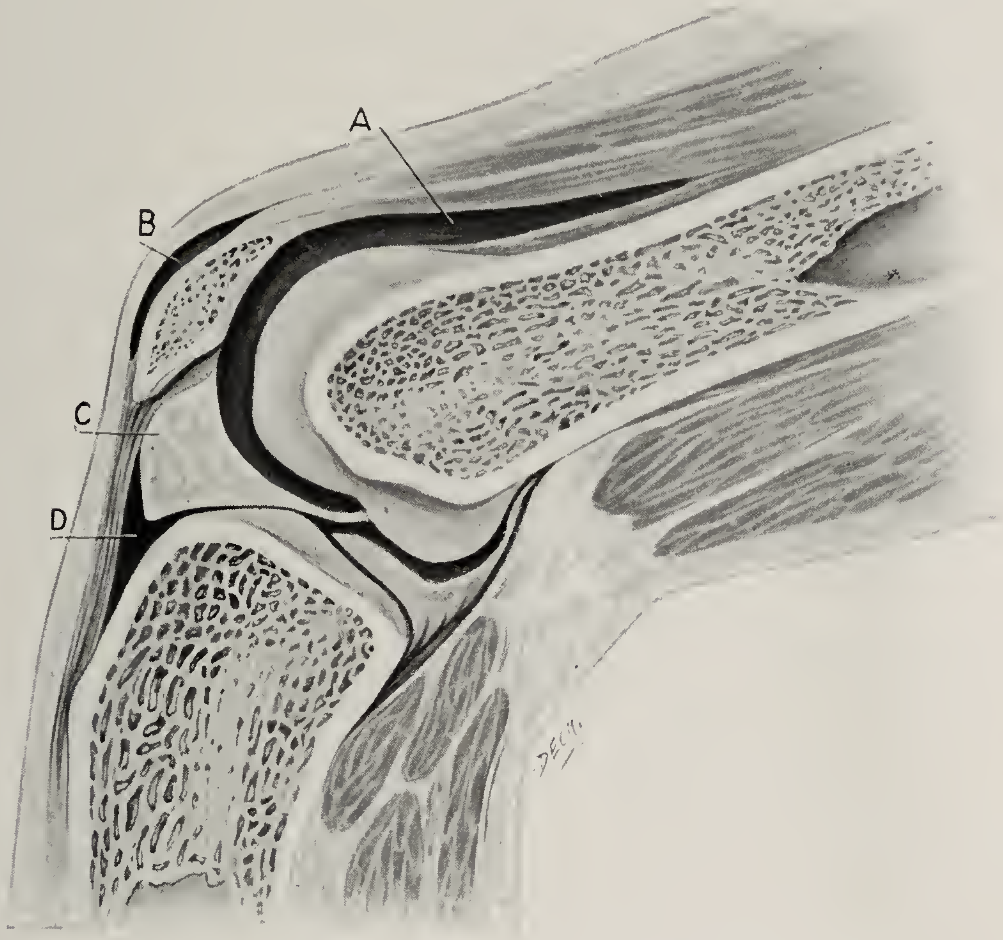

Fig. 817.—Sagittal Section through the Knee-joint.
A, Suprapatellar bursa; B, prepatellar bursa; C, ligamentum mucosum and ligamenta alaria genu; D, deep infrapatellar bursa.

Diseased conditions of the other bursae in the neighborhood of the knee are sometimes observed. The bursa of the popliteal muscles appears as a rounded tumor in the external portion of the popliteal space, which becomes more prominent as the knee is flexed. These swellings communicate with the knee-joint, and hence, if they are punctured or incised this fact must be borne in mind. It is better not to treat these cases operatively unless they become troublesome; in any event, the effect of compression should be first tried.

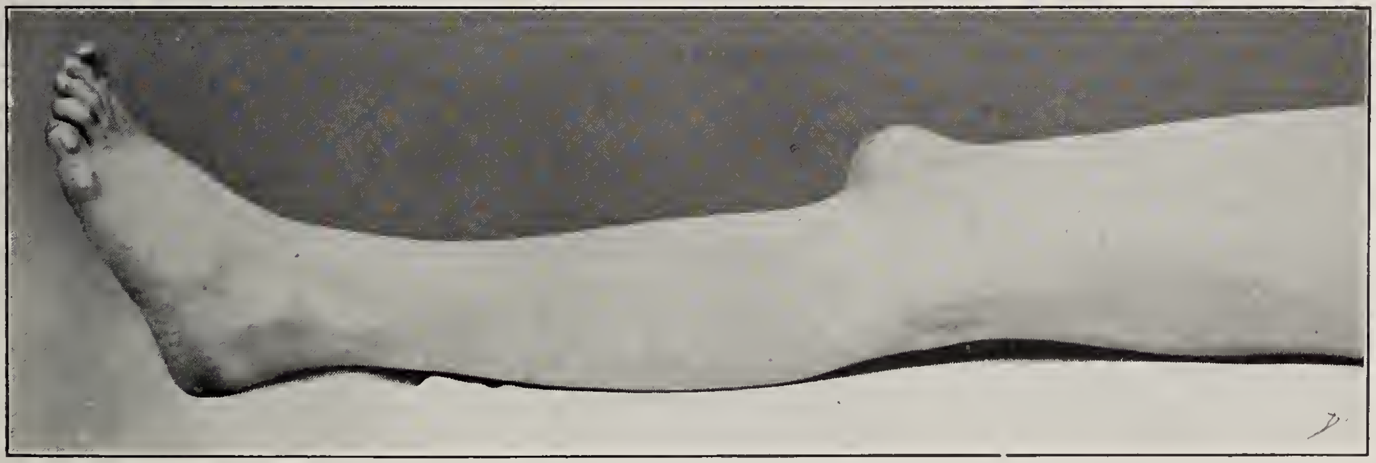

Fig. 818.—Housemaid's Knee.

There is a small bursa situated in the fascia covering each condyle where the lateral ligaments are inserted, which may become inflamed (Hueter). These bursae may become the seat of acute suppurative inflammation, hygromas, or hematomas, which are liable to be mistaken for diseases of the knee-joint or of the femur.

Serous inflammation of the **deep infrapatellar bursa** (Fig. 817, D) has been observed (Trendelenburg). It appears as a fluctuating swelling just above the tubercle of the tibia. At a point somewhat lower another bursa is sometimes found (the pretibial bursa), which also becomes inflamed.

Inflammation of the **bursa semimembranosa** also occurs. This bursa lies between the muscles of the same name and the inner head of the gastrocnemius; it may, though rarely, communicate with the knee-joint. Its temporary disappearance under pressure shows such a communication.

The treatment of the three last is conducted on the same lines as that of prepatellar bursitis. The most rigid asepsis is required, on account of possible communication with the joint.

Tumors in the Region of the Knee=joint.—The most important tumor found in this neighborhood is **sarcoma.** It occurs here more frequently than in any other place on the extremities. This fact is probably due to the high intensity of bone growth in the lower end of the femur and the upper end of the tibia. These sarcomas sometimes appear just at the termination of the growth of the bone, though they also appear during the period of growth, before the twentieth year. They originate most frequently from the medulla (**myelogenic sarcomas**); less frequently from the periosteum. Springing from the medulla they grow in the direction of the joint, particularly in the case of those at the lower end of the femur, but, as a rule, they do not perforate the cartilage and the capsule, though the joint becomes swollen as the result of serous effusion. In the commencement it is difficult to distinguish these growths from tuberculous disease of the knee-joint. Later on, as the cortical lamella becomes invaded the size of the growth reveals its true nature. In highly vascular joints aneurismal sounds may sometimes be detected by the stethoscope or phonendoscope. The appearance of large veins on the surface of a growth at the knee should always excite suspicion of sarcoma.

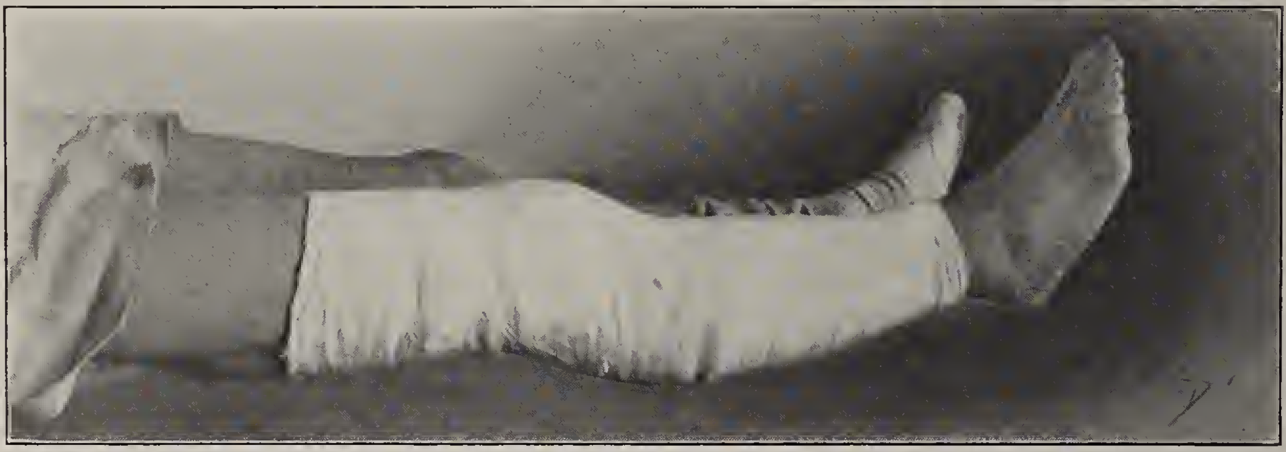

Fig. 819.—Plaster-of-Paris Splint for Acute Prepatellar Bursitis.

The **femur** is particularly liable to sarcoma between the fifteenth and the fortieth year, specially at its lower third, where the disease runs a rapidly fatal course. The **tibia** is not nearly so frequently affected as the femur, myelomas being more frequently observed in this bone. The disease does not run such a rapid course as in the case of the femur, and the lesser malignancy permits it to attain a larger growth.

Both the **prognosis** and the **treatment** of sarcoma in this region are unsatisfactory. If the disease occurs in the femur, amputation at the hip-joint should be performed. Even then metastases occur in the lungs and liver. Amputation of the upper portion of the thigh may be practised in cases in which the disease occurs in the tibia. The section should be made as far as possible from the seat of the disease, without sacrificing the structures necessary for a stump for an artificial limb. In inoperable cases injections of the **mixed toxins of the Streptococcus erysipelatis** and **Bacillus prodigiosus** may be given a trial (see Vol. I, pages 179 and 226). Sarcomas may also originate in the fascia, the vessel sheaths, and the lymphatic glands in the neighborhood.

The lower portion of the femur is a favorite site for **cartilaginous exostosis.** It appears as a spongy, rounded tumor which springs from the bone, has an uneven surface, and is covered with cartilage. Sometimes it is covered by a capsule filled with synovial fluid, and in isolated instances free portions of hyaline cartilage have been found in the sac, the conditions present thus simulating those of a true joint. These exostoses, occurring usually in early childhood and so constantly situated near a joint, are probably due to early aberration of growth of a cartilaginous nucleus, and in adults to the presence of fetal cartilage. The relation of the tumor to the adjacent joint is interesting. Owing to the growth of the bone, in some instances the tumor follows the diaphysis and advances in an upward direction, while in others its position with reference to the epiphysis is such that it remains attached to the latter. In the former case the growth will be situated outside the capsule from the beginning, while in the latter case it will be intracapsular in the commencement (Stanley, Volkmann), but with growth of the tumor or recession of the capsule a portion of the latter remains, forming a bursa in connection with the exostosis. Several cases coming under my observation were extracapsular from the commencement, since there was no bursa present. These growths occur sometimes in connection with exostoses elsewhere, and affect even several members of the same family. I have observed this in four of the female members of a family, the growths occupying the lower epiphysial line of the femur, and the upper epiphysial lines of the tibia and humerus (**multiple exostosis**). In one instance of the latter the exostosis finally developed into a sarcoma of exceedingly rapid growth.

These growths should be excised under the strictest aseptic precautions. Their proximity to the joint, and the possibilities of invading the latter during the operation should be borne in mind.

Bone abscesses of tuberculous origin sometimes make their appearance at the lower end of the femur, and the upper end of the tibia, simulating tumors very closely. They are to be treated by chiseling away sufficient bone to allow thorough curetment and drainage. As soon as aseptic conditions are established the filling up of the defect may sometimes be hastened by the implantation of decalcified bone chips (Senn).

Echinococcus cysts cause enlargement of the lower end of the femur and the upper end of the tibia. These are slow in growth, and usually painless at first; they may become painful in the later stages. The eruption of the cyst through the cortex and in the soft parts usually discloses its true nature. The **treatment** consists in chiseling away sufficient bone to gain free access to the interior, and thoroughly scraping out the cavity. **Amputation** may have to be resorted to in some cases.

Among the tumors of the soft parts in this neighborhood is to be mentioned **aneurism of the popliteal artery.** This occurs at the bifurcation of the vessel into the anterior and the posterior tibial artery and is due, as is aneurism elsewhere, to endarteritis deformans. Aneurism of the popliteal artery is by far the most frequent of those occurring on the extremities. Aneurism of the popliteal may long remain latent, and suddenly, in alcoholic patients, give rise to gangrene of the extremity (Tillmanns). In the **treatment,** while compression (digital, elastic, and by forced flexion of the knee) may be tried, the most trustworthy means at our command is ligation at both sides of the sac and of all branches given off at the aneurism, and extirpation of the aneurismal sac (Antyllus). Special care must be taken in dissecting the sac of the aneurism from the popliteal vein to avoid injury to the latter, ligation of which has been followed by gangrene of the foot or leg. In order to avoid this accident it is better not to excise the entire sac, and to pack the remainder. The prognosis in idiopathic and old aneurisms is better than in recent traumatic ones. Kohler collected 14 cases of aseptic extirpation of popliteal aneurism without an unfavorable result.

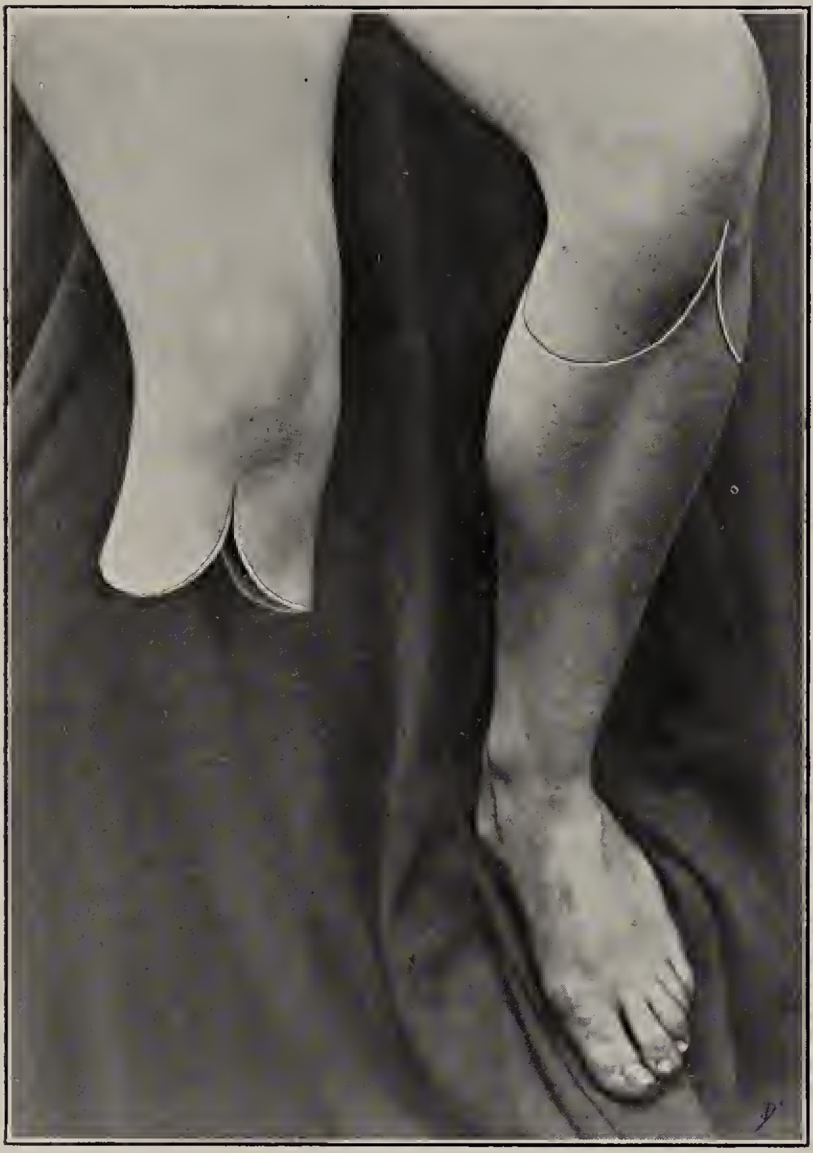

Fig. 820.—Amputation at Knee-joint by Lateral Flaps.

The operation of Matas (see Vol. I, page 346) is worthy of trial in popliteal aneurism.

Amputation through the Knee-joint.—In Stephen Smith's method two lateral flaps are made, commencing an inch below the tubercle of the tibia and carried in a half circle to meet behind the knee-joint (Fig. 820); the inner one is slightly longer than the outer one. The skin and subcutaneous connective-tissue flaps are dissected to the level of the knee-joint, the ligamentum patellae is divided, and, with the knife kept close to the bone the semilunar cartilages are separated from the tibia. The flaps are well retracted and the remaining connections severed. The preserved semilunar cartilages act as a cap over the end of the femur. When union is completed, the cicatrix lies behind in the intercondyloid notch and out of the way of pressure.

In the **circular method,** with the knee extended, the skin is divided by a circular incision from three and a half to four inches below the lower margin of the patella. The skin cuff is dissected up all around as far as the patella, lateral incisions being made to facilitate this, if necessary (Fig. 821). The knee-joint is now flexed, the patellar ligament divided at the patella, and the capsule and the lateral ligament divided close to the lower border of the femur. The semilunar cartilages remain attached to the tibia. The crucial ligaments are divided with the knee in forced flexion, and the soft parts in the popliteal space divided from before backward with the leg extended. The wound is sutured transversely and drained at the angles. In case of disease of the patella or the upper recess of the synovial cavity, these parts are removed through a longitudinal incision over the patella.

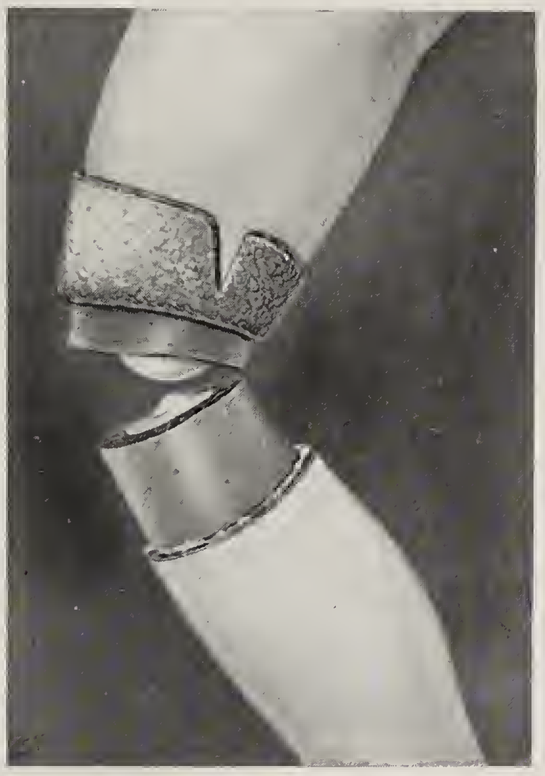

Fig. 821.—Disarticulation of the Knee by Means of Circular Incision.

The long anterior and short posterior flap method is as follows: A long anterior flap is made, including the patella, which is turned up. The joint is now opened from in front, and the amputation completed by cutting from within outward and downward (Fig. 822). In the **long posterior flap method** a U-shaped posterior flap of skin and muscle is made which extends below the middle of the calf, and a slightly curved incision is made in front which divides the ligamentum patellae and opens the joint.

Transcondylar or Supracondylar Amputation.—This consists in sawing off the articular surface of the femur, either through the condyles or above, the sharp edges being rounded off (Carden, Lücke, C. Heine). The bone may be sawed off in a rounded form (Bergmann). In **osteoplastic amputation** (Gritti of Milan, 1857) the anterior flap is made by placing the upper ends of the incision well behind the condyles and its lower portion at least two fingerbreadths below the lower margin of the patella (Kocher). The patellar ligament is cut, the flap turned up, and disarticulation effected by cutting a short posterior flap, the amputation knife being passed from before backward through all the remaining soft parts. The cartilaginous surfaces of the femur and of the patella are now sawed off, and the two sawed surfaces brought together (Fig. 823). Ssabanejeff makes the bone flap from the tibia by making an anterior flap and opening the knee-joint from behind (Fig. 824).

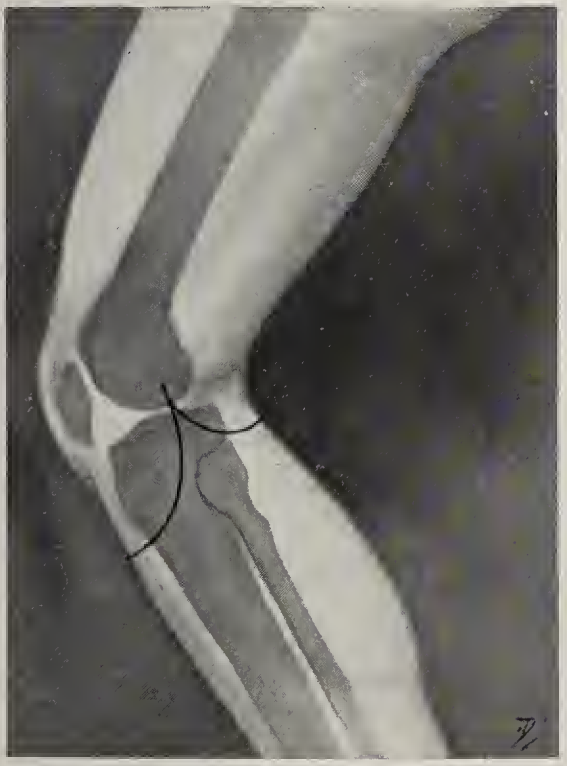

Fig. 822.—Amputation at the Knee-joint by Anteroposterior Flaps.

The **choice of operation** should be based on the requirements and conditions of each case. In old persons with a thin cutaneous covering and rarefying ostitis present, the Carden-Lücke amputation is to be preferred. In young adults and the middle-aged with good, thick, and well-nourished tissues about the knee, Gritti's operation has the advantage in that the femur and patella do not atrophy after they have reunited and the stump maintains its broad, rounded contour. Amputation through the joint gives a broad serviceable stump, but does not give good access to the upper recess of the joint, when this is necessary, except by a longitudinal incision in the flap; this may imperil the integrity of the latter, besides bringing the scar tissue in an unfavorable location when the healing process is completed.

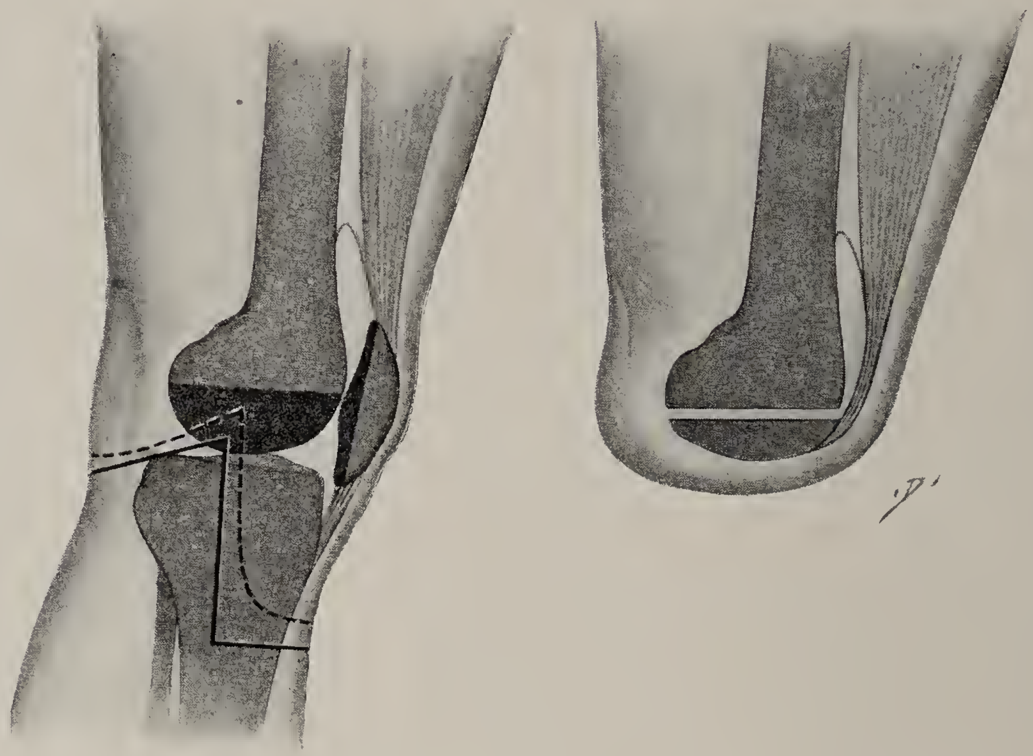

Fig. 823.—Gritti's Transcondyloid Amputation (Diagrammatic).
Shows skin incisions and bone section. Heavy line indicates Gritti's original line of incision. The dotted line indicates the author's line of incision.

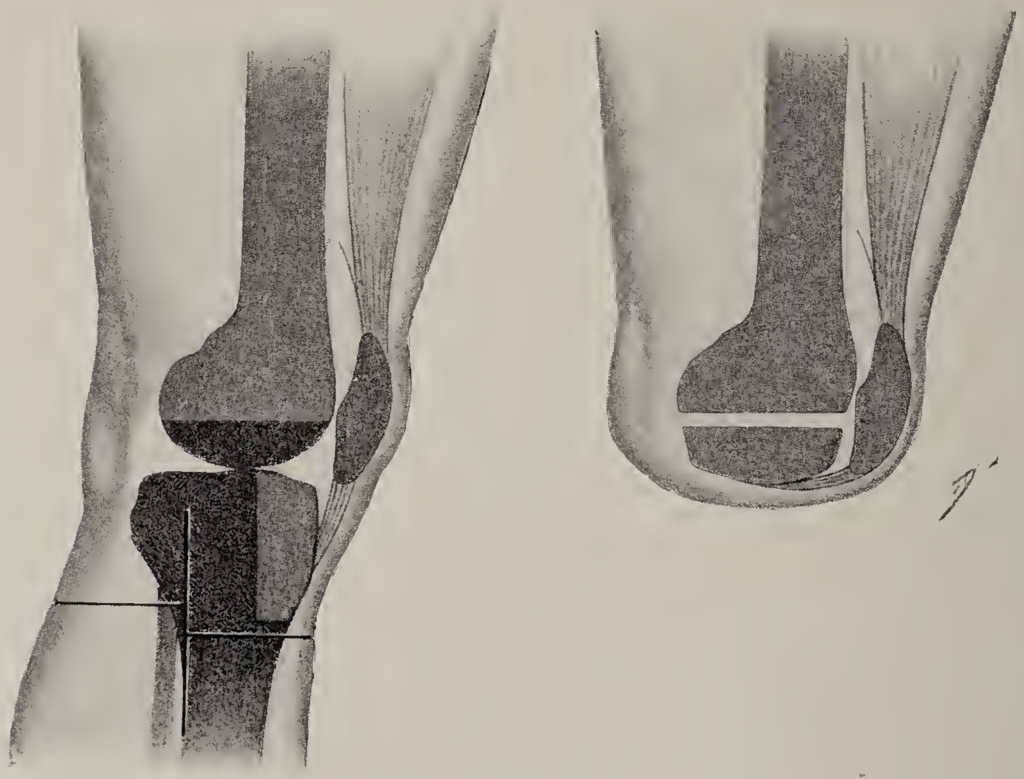

Fig. 824.—Ssabanejeff's Operation.
Showing skin incision and bone section (diagrammatic).

Sequestrotomy at the Lower End of the Femur.—Acute osteomyelitis is specially frequent in this locality and sequestrotomy is required for the removal of cortical sequestra from the posterior surface of the femur. The fistulous openings lie at the outer edge of the vastus externus, or the inner edge of the vastus internus, and care must be taken, in enlarging those in the latter situation, to avoid injury to the artery and vein where these pass through Hunter's canal; in both locations the joint capsule must be avoided.

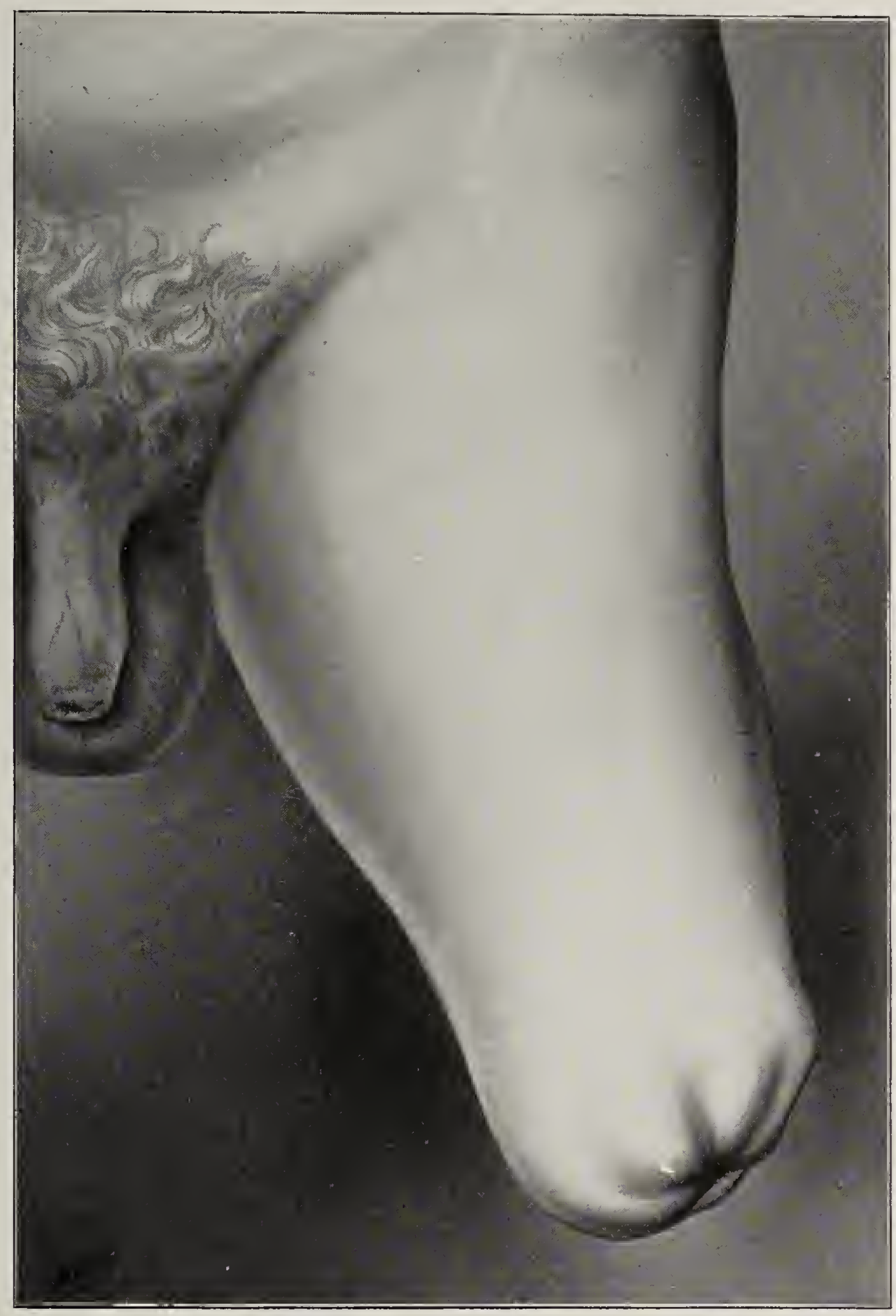

Fig. 825.—Appearance of the Stump Following Amputation by the Circular Method, Showing the Objectionable "Puckering" of the Cicatrix.

The operation is often embarrassed by the sequestra lying deeply and surrounded by a thick layer of newly formed bone. In mild cases the subperiosteal exudate is serous instead of suppurative (*périostite albumineuse,* Ollier). This, however, is something more than a periostitis; Hueter demonstrated oil globules in the exudate, proving the presence of osteomyelitis with secondary periostitis.

Amputation of the Thigh.—Amputation at the junction of the middle and lower third may be performed by **circular, flap,** or **oval incisions.**

If the skin and muscular structures are intact, the circular incision at one level for the skin and at another for the muscular structures may be employed. While this method is a rapid one, the resulting cicatrix frequently "puckers" in the center of the face of the stump, thus producing a number of folds that become sources of irritation of the skin, eczematous conditions, etc. (Fig. 825). In flap amputations in the thigh the remains of the muscles disappear in time, as a rule, and for this reason Bruns insisted that only the skin, subcutaneous tissue, and fascia should be included in the amputation. A long anterior flap containing these structures, and a short posterior one are useful (B. Beck). Lateral flaps and oval incisions are to be employed only in cases where the injury is of such a character as to compel departure from methodic procedures.

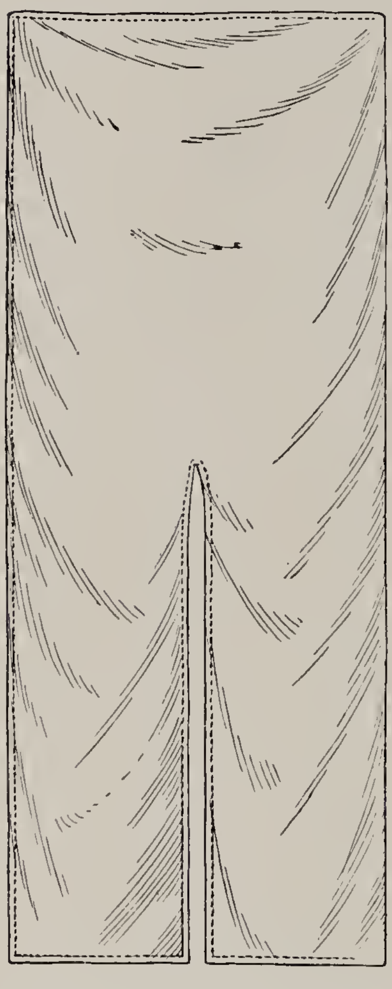

Fig. 826.—Two-tailed Retractor or Retracting Compress.

The operator, in the case of the right limb, stands on the outer side; in the case of the left limb, between the limbs. For the purpose of temporarily excluding blood from the general circulation and storing it to assist reaction after the amputation, the other limb may be allowed to hang from the table. After the vessels of the extremity are filled, a bandage is placed around the base of the thigh sufficiently tight to arrest the return circulation only. **Prophylactic hemostasis** is to be secured by the Esmarch bandage and elastic constrictor. The circular incision is to be made by one cut through the skin, subcutaneous tissue, and fascia with the long amputating knife, at a point equal to one-third of the transverse diameter of the thigh below the point of proposed section of the bone. The cuff is dissected up and strongly retracted by an assistant. The muscles are divided to the bone, including the periosteum, at the point of reflection of the cuff, and the muscular mass and periosteum are pushed up so as to permit section of the bone an inch farther up. They are held back by a retracting compress (Fig. 826). In making the section of the bone, the heel of the saw is placed on the bone and drawn toward the operator so as to make a groove for the saw to work in. The bone section is then completed by long but light sweeps of the saw for its entire length. The linea aspera must not be sawed last, since it is the most brittle portion of the bone and splinters easily. The femoral artery and vein are easily recognized (Fig. 827) and tied at once. The constriction is removed and the remaining vessels ligated. The sciatic nerve is to be drawn out and its accompanying vessel isolated before the nerve is divided and permitted to retract; otherwise the vessel may also be divided and retracted.

In **lateral flap amputation** the same steps are followed after the flaps are fashioned and retracted. In **oval incisions** the operator grasps the thigh with his left hand above the point of intended section and shapes the oval on the side nearest him, *i. e.*, in the case of the right limb on the outside, and in the case of the left on the inside.

Amputation by an Anterior Skin Flap and a Posterior Flap of Skin and Muscle.—This, the so-called **"mixed method,"** consists in raising an anterior flap of skin and fascia, and making a posterior flap containing muscle, fascia, and skin. The surgeon stands on the right side of the limb to be amputated, places the thumb and forefinger of his left hand on either side of the limb on the level of the intended section of the bone, begins the incision at the point of the finger, carries it down that side of the limb for about four and a half inches, sweeps it across the limb with a broad convexity, and carries it up on the side nearest him as far as his thumb. The flap thus cut is dissected up, the limb transfixed with the long amputating knife, and the posterior flap cut from before backward, the knife hugging the bone until it has reached a point nearly opposite the site of the lower boundary of the anterior flap, when it is carried directly backward (Fig. 828). The flaps are held well retracted and the muscles in front are divided with a circular sweep of the knife. The bone is then divided with the saw as previously directed (*vide supra*).

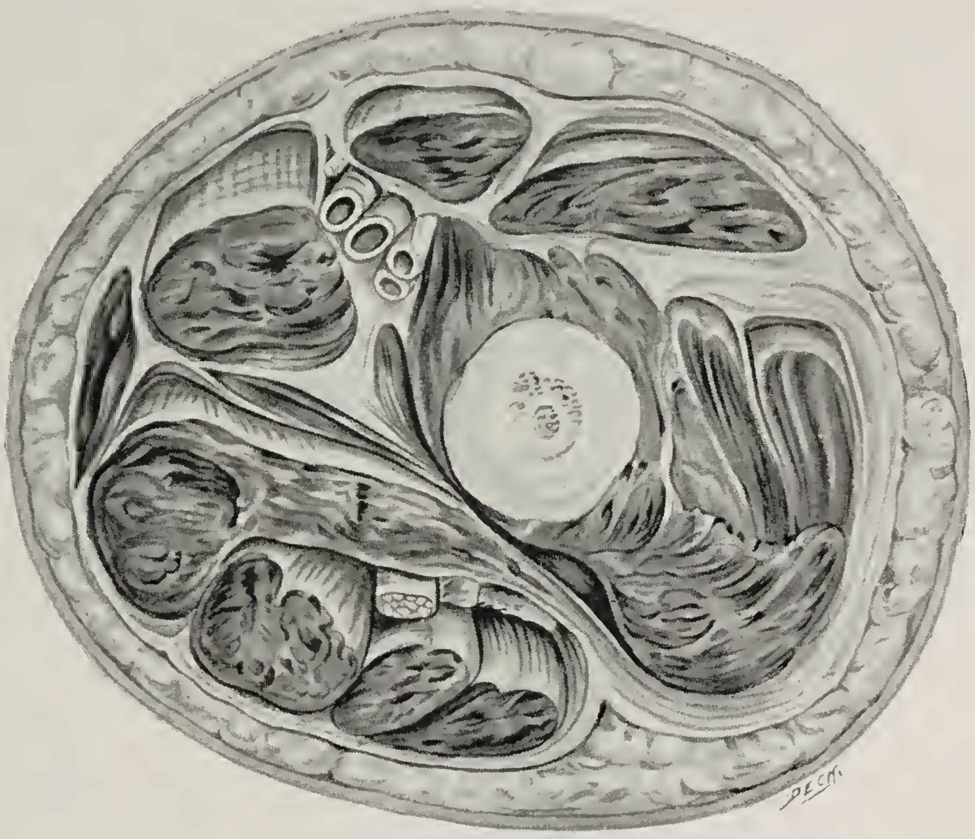

Fig. 827.—Transverse Section through Left Thigh at its Middle Third.

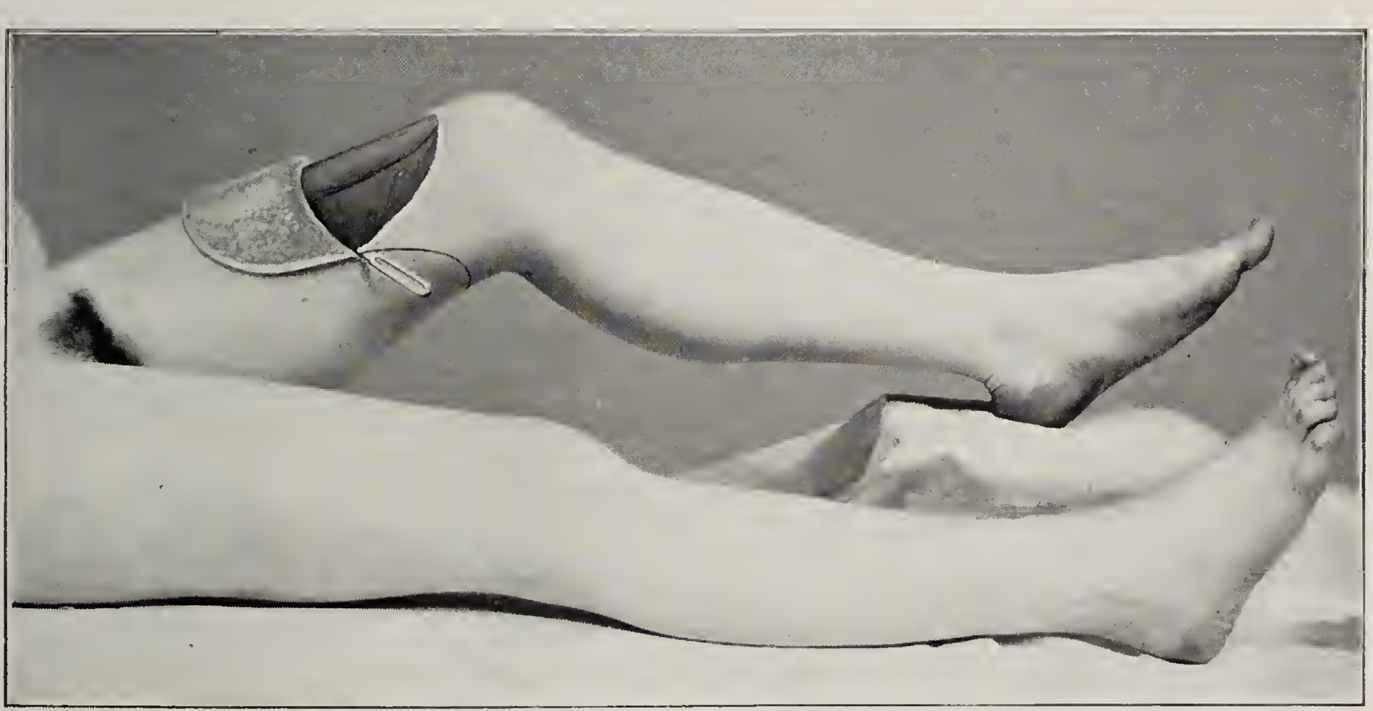

Fig. 828.—Amputation through the Thigh by the Mixed Method.

Choice of Operation.—The circular operation is well adapted to the cases of wasted thigh in young subjects. The tendency of the posterior muscles to retract more than the anterior is compensated for by cutting these three-fourths of an inch longer than those in front. The lateral flap method is objectionable from the fact that the iliopsoas muscle tilts the sawed end of the femur upward and makes pressure against the upper angle of the flaps, where it is liable to come through and become necrotic, or to adhere to the cicatrix. It should be made use of only when the injured parts will not admit of the circular or mixed incision.

The method of mixed anteroposterior flaps and circular division of the muscles has the following advantages: (1) the bone is well covered by the anterior flap; (2) the flap can be taken from the neighborhood of the knee-joint and patella; (3) it is a quick method; (4) it is suited to all cases; in very muscular subjects the entire thickness of the posterior muscular structures should not be utilized; (5) it gives good drainage (Jacobson).

THE LEG AND FOOT

Fractures of the Bones of the Legs.—Fractures of the bones of the leg, next to fractures of the forearm, are the most frequent of all the fractures (16.5 per cent, Gurlt). In the region of the junction of the middle with the lower third or at the lower third, not only almost all the fractures due to indirect force, but also many due to direct force, are observed. This is due to the brittleness of the bone where the very thick cortical lamella of the middle third merges into the thinner lamella of the lower third. The susceptibility to fracture at this point is enhanced by the outward convexity of the bone.

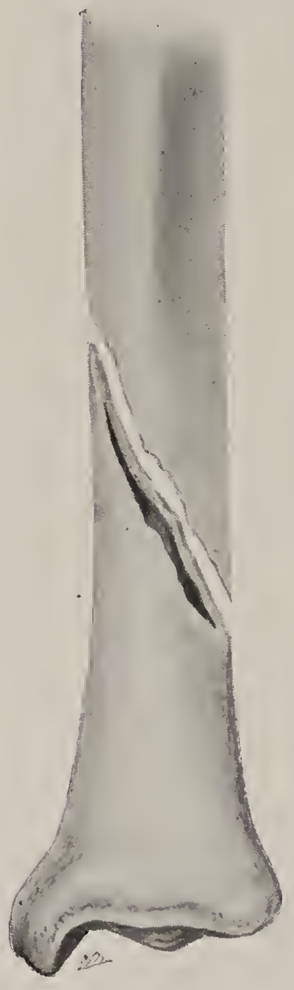

Fig. 829.—Fracture of the Lower Third of the Tibia (en flûte).

The course of the line of fracture at this point is quite constant; it passes obliquely from above and behind downward and forward, or downward and outward. The lower fragment is drawn upward and backward by the muscles of the calf. The angular-pointed lower end of the upper fragment resembles the mouth of a flute (*en bec de flûte* of the French, Fig. 829). This pointed end frequently perforates the skin. The weight of the foot falling outward causes eversion of the lower fragment. The oblique course of the fracture line, therefore, favors both **longitudinal** and **lateral displacement** and **outward rotation.**

The tibia and fibula, as a rule, break simultaneously. The fibula gives way from the weight of the body. Fracture of the tibia alone is rare except in the case of gunshot wounds. In the majority of cases the indirect fracture of the fibula lies on a plane from two to four inches higher than that of the tibia.

These fractures are easily recognized. Fractures with impaction and fractures in children at the lower end may embarrass the diagnosis in the absence of crepitus and abnormal mobility. The pointed edge of the upper fragment can very often be felt beneath the skin. The hematuria following this fracture is almost always very large. **Transverse fracture** is rare. The bone is sometimes broken in two places with a square or three-cornered fragment between. The line of fracture may follow a spiral shape. Longitudinal fissures, particularly in gunshot fractures, may involve the neighboring joint. Comminuted fracture is not uncommon, occurring for the most part from crush accidents and from gunshot wounds.

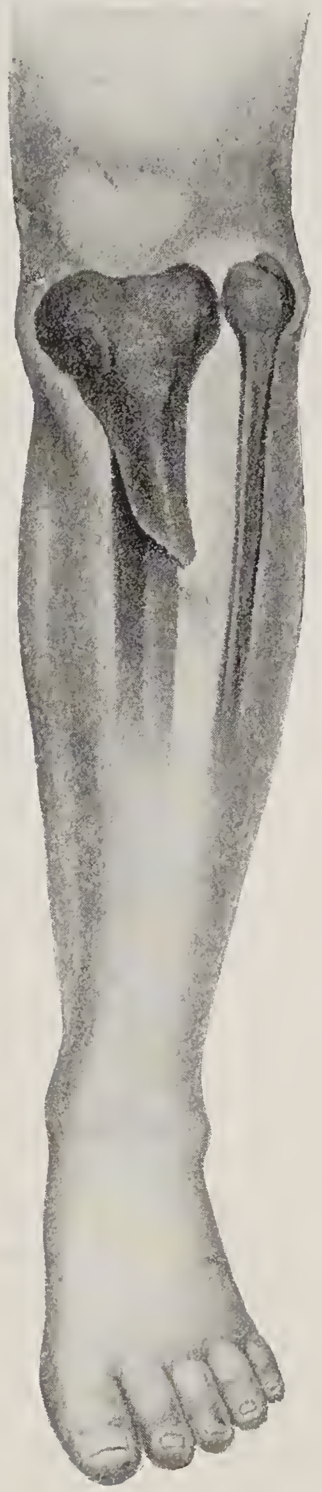

Fig. 830.—Fracture of the Tibia. Showing longitudinal and lateral displacement and outward rotation.

Compound fractures of the leg are very common. If not due to the original accident, they are liable to be produced by the careless handling of the patient afterward. The mortality of compound fracture at the present time, owing to adherence to aseptic and antiseptic rules, is very small, whereas in former times it amounted to 38.5 per cent (Volkmann).

Isolated fractures of the fibula, exclusive of fractures of the external malleolus, are very rare. Fractures of the upper end of the fibula are rare and unimportant. Fractures of the tibia with dislocation of the head of the fibula are sometimes observed.

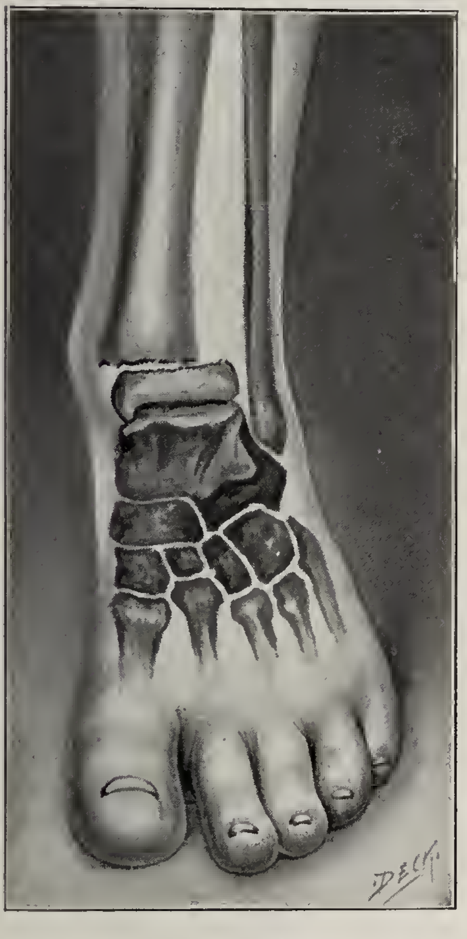

Fig. 831.—Supramalleolar Fracture.

Supramalleolar fracture of the tibia and fibula is of special surgical interest (Fig. 831). The ankle-joint is generally involved. The fracture usually arises from indirect violence, in which the astragalus causes the fracture by being driven between the malleoli. Direct fractures are produced by violent abduction or adduction of the foot, the fracture resulting partly from pressure from the astragalus, and partly from traction on the lateral ligaments. The upper fragment may perforate the skin. The foot follows the lower fragment in either an outward or an inward direction. This fracture may be mistaken for a dislocation of the ankle. In fracture the deformity is easily overcome by traction, but is reproduced as soon as the traction ceases; in dislocation the deformity cannot be overcome except by certain movements, and does not recur. In the treatment of supramalleolar fracture the application of lateral bass-wood splints after reduction is efficient; plaster-of-Paris encasement may be substituted for these later, when the swelling has subsided.

Fracture by eversion and abduction of the foot, commonly known as **Pott's fracture,** is one of the most frequent of the fractures of the leg. It is of special surgical importance from the fact that it is frequently overlooked, and even when recognized the cardinal principles of its treatment are often neglected with resulting deformity and disability. The cause is a twist of the foot aided by the weight of the body. In the typic form the force is exerted through the internal lateral ligament; the internal malleolus is broken at its base; this presses the external malleolus outward and fractures the fibula just above the malleolus (Fig. 832). All grades of the injury are observed. In some instances the deformity is slight, but can be easily produced by the abnormal lateral mobility present. The strain on the internal lateral ligament may carry away a small portion of the tibial malleolus by an oblique fracture, and the fibula may be broken three or four inches above the malleolus. These differences cannot always be made clinically, but the essential lesion giving rise to loss of support on the inner side of the ankle, the separation of the two bones of the leg and the consequent widening of the mortise within which the astragalus moves, should not be lost sight of. In addition to the abduction, eversion, and widening of the ankle, there is more or less backward displacement (Fig. 833). In rare instances **fracture of the posterior portion of the articular surface of the tibia** occurs, in which case the displacement of the tibia is forward. Undue prominence of the internal malleolar fragment, due either to rotation on its anteroposterior axis or to the interposition of a large strip of periosteum, may require reduction through an incision (Stimson).

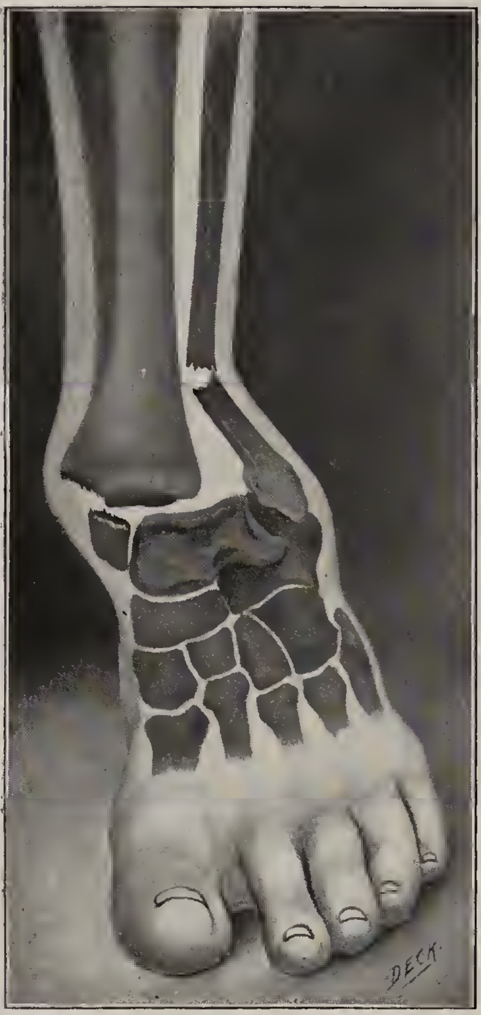

Fig. 832.—Typic Pott's Fracture.

The **treatment of Pott's fracture** consists in reduction by adduction of the foot while the os calcis is pressed strongly forward and inward. An anesthetic may be required. In forward displacement of the tibia the foot must be brought well forward. The reduction is maintained by support laterally and posteriorly. This may be accomplished by a plaster-of-Paris bandage with the foot held in a position of overcorrection, the sole being turned strongly inward, until the plaster sets. Or, a posterior and

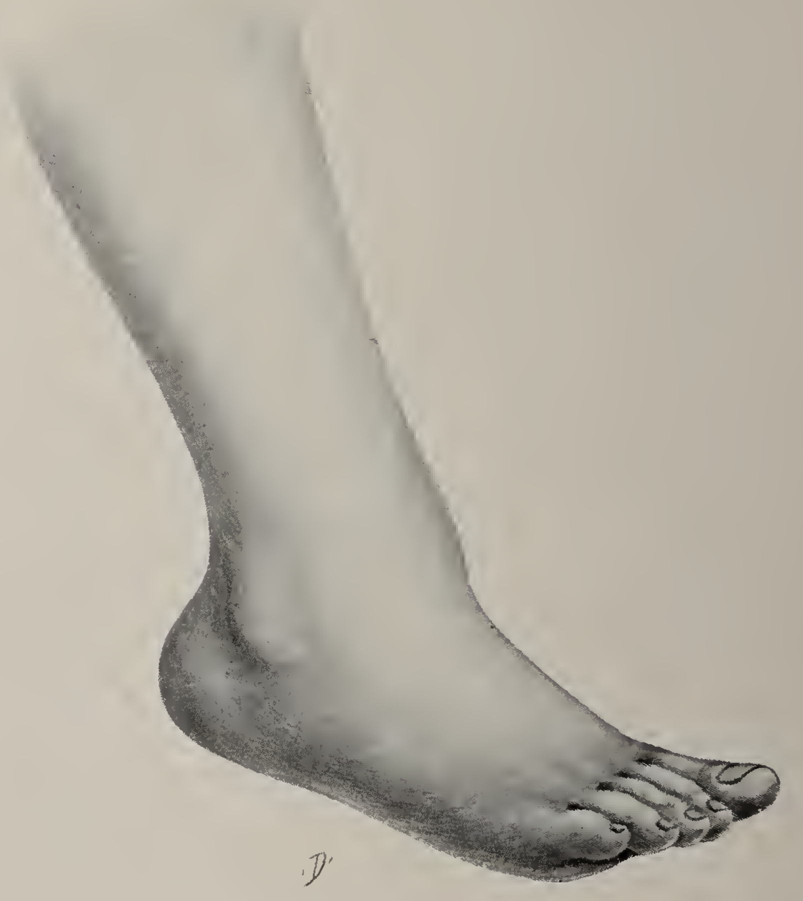

Fig. 833.—Pott's Fracture. Backward Displacement of the Foot.

a lateral splint of plaster-of-Paris may be made of 12 or 15 layers of a four-inch wide plaster roller (Stimson). The posterior splint extends from the toes, along the sole, and up the calf nearly to the knee. The lateral one commences just in front of the external malleolus, passes over the dorsum of the foot to the inner side, thence under the sole and up along the outer side of the leg. The splints are molded to the limb and bandaged with a roller while still wet. The reduction is maintained while the plaster is setting. The precept to treat all sprains in the region of the ankle as fractures until the diagnosis is positively assured will save patients much suffering and surgeons much humiliation.

In **old unreduced Pott's fractures** the site of the fracture of the fibula is exposed by an incision and the lower fragment again detached. A second incision is made commencing at the same level on the inner side of the tibia, sufficient in extent to expose the malleolus fully, when the original fracture is reproduced with a chisel, the tibia protruded from the wound, the astragalus liberated, and any new bone that may have been formed cut away. The reduction is then effected and the wounds closed and dressed in the usual manner.

Fractures of the malleoli by eversion of the foot result in a malleolar fracture which may include that of the fibula alone, or the tip of the internal malleolus in addition. In a third form the entire internal malleolus may be broken off. The last results in impairment of motion of the ankle-joint. Independent mobility and tenderness at the tip of the corresponding malleolus in the case of the first two forms, the recognition of the line of fracture by tenderness on pressure, and the irregularity produced by the displacement upward and inward of the fragment, suffice for the diagnosis. In the **treatment** of the form of fracture where simply the tips of the malleoli are broken off, immobilization by plaster-of-Paris with the foot well pressed inward will fulfil all the indications. Where a large fragment of the internal malleolus is broken off with displacement the latter must be corrected by pressing the fragment downward and outward, and securing immobilization with the foot well forward to guard against backward displacement; the fragment must be pressed well in place to guard against inward displacement.

Complications of Fracture of the Leg.—In addition to the frequency of compound fractures, and the occasional comminution of the fragments, injury of the principal vessels is sometimes met with. Both tibial arteries, the peroneal, as well as the nutrient artery of the tibia, may be injured. Injury of the nerves is rare. Aneurism may complicate the fracture, and be opened by mistake for an abscess (Mouret). Stimson records a case in which secondary hemorrhage in a fracture from direct violence without displacement took place on the eighth day.

The **prognosis** of a simple fracture of the leg is favorable. In transverse fractures union follows in about six weeks. In very oblique fractures the union is much slower, and failure of union is not uncommon. Atrophy of muscles due to ischemia may follow. Complete recovery may be long delayed by stiffness at the ankle, tenderness of the skin, enfeebled circulation, and neuralgic pains. This is specially true of the old and rheumatic. In compound fractures if the suppuration is free the recovery will be much prolonged and the presence of necrosed bone will lengthen still further the period of convalescence.

Treatment of Fractures of the Leg.—Traction on the leg with the knee slightly flexed to relax the calf muscles will generally effect reduction of the displacement. Spasm of the muscles, as a rule, is the chief obstacle to reduction in difficult cases. To overcome this, compression of the femoral artery has been recommended by Broca. A hypodermic injection of a quarter of a grain of sulfate of morphin is very useful in overcoming the spasm. An anesthetic should be employed in obstinate cases to permit manipulation of the fragments into position. Interposition of muscular tissue will render complete reduction impossible in a few cases. Continuous traction to overcome the spasms may be employed. A fan-shaped piece of adhesive plaster applied to each side of the leg *above* the point of fracture in such a manner as to embrace the posterior muscular mass particularly, bandaged in place and, with the ends carried below the foot, connected with a weight and pulley extension apparatus will relax the muscles in a day or two and permit accurate adjustment. The apparatus of Kaefer (Fig. 834) is designed to secure coaptation by forcing the torn fragments downward, the upper portion of the leg being employed as counter-pressure. In using this device the traction made under an anesthetic is kept up until a plaster-of-Paris splint is applied and hardens. This is then divided transversely at the site of the fracture, and in each half is incorporated with a fresh plaster bandage a stud on a metal plate. One of the studs has a right-hand screw and the other a left-hand one. These carry a rod with corresponding threads cut on each end. After thorough setting of the plaster the two halves of the splint are separated from each other by turning the rod until the required adjustment is obtained.

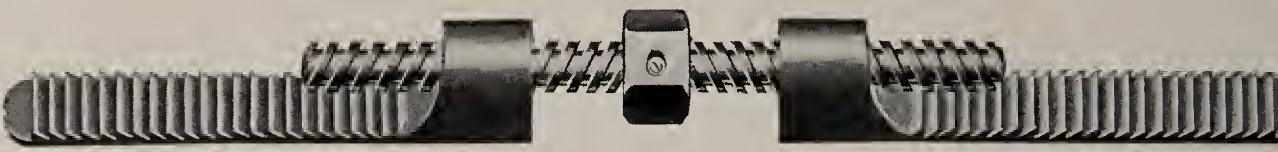

Fig. 834.—Kaefer's Apparatus for Adjustment of Fragments in Very Oblique Fractures of the Leg.

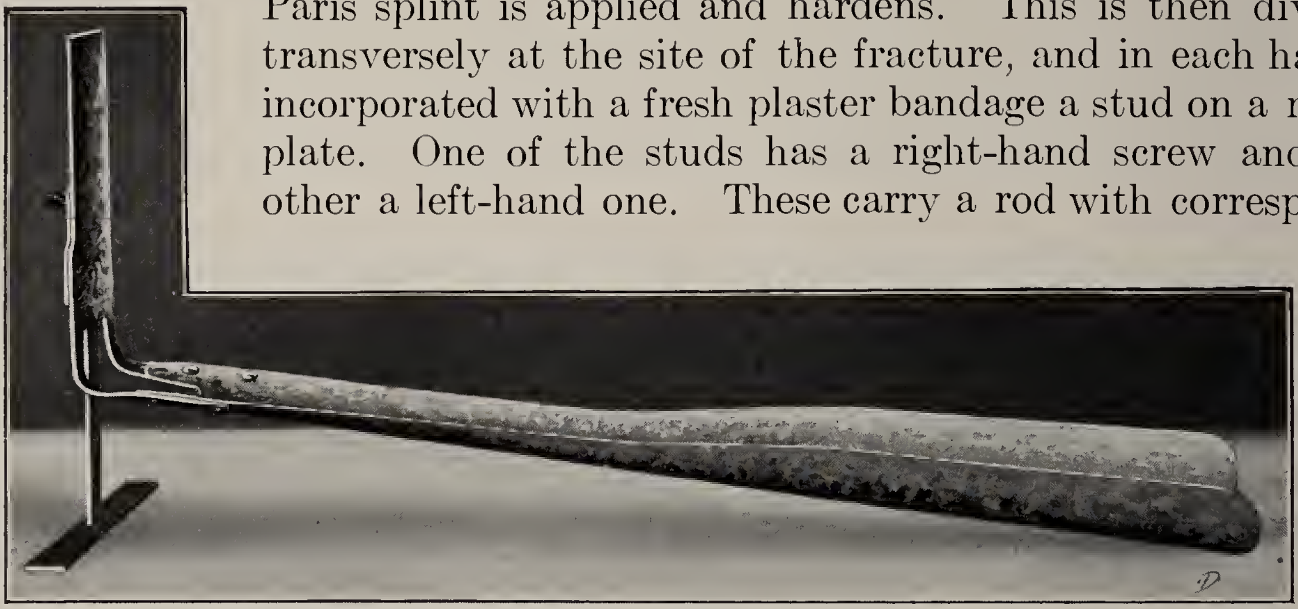

Fig. 835.—Volkmann's Posterior Leg Splint.

When the fracture is nearly transverse and denticulated or toothed, retention is not difficult and the leg may simply be placed in a Volkmann (Fig. 835) splint for about a week, when it should be put up in plaster-of-Paris. The stocking bivalve plaster splint (Fig. 836) is made of two pieces of muslin cut in the shape shown in the figure and in size to fit the limb, and stitched together in the middle. Between the two layers of each lateral half are laid

12 or 15 layers of gauze, cut slightly smaller than the corresponding half of the splint and soaked in plaster cream. The whole is then bound in place. If the limb swells or inspection is necessary, the bandages are loosened and the two sides of the splint turned down, the line of stitching behind acting as a hinge (Stimson). A permanent plaster-of-Paris dressing is applied following the subsidence of the swelling and the assurance that the reduction is as complete as possible.

In cases of persistent spasm and tendency to displacement the double inclined plane may be employed to advantage (Fig. 838).

In **compound fracture** the usual cleansing and disinfection of the parts already described (see page 135) having been accomplished and the loose fragments removed, the question of the retention of the fragments must be decided on in the individual case. As a rule, the Volkmann splint or the stocking bivalve splint serves a useful purpose until the time comes when the limb can be encased in plaster-of-Paris; a fenestra cut at the site of fracture may be added, if

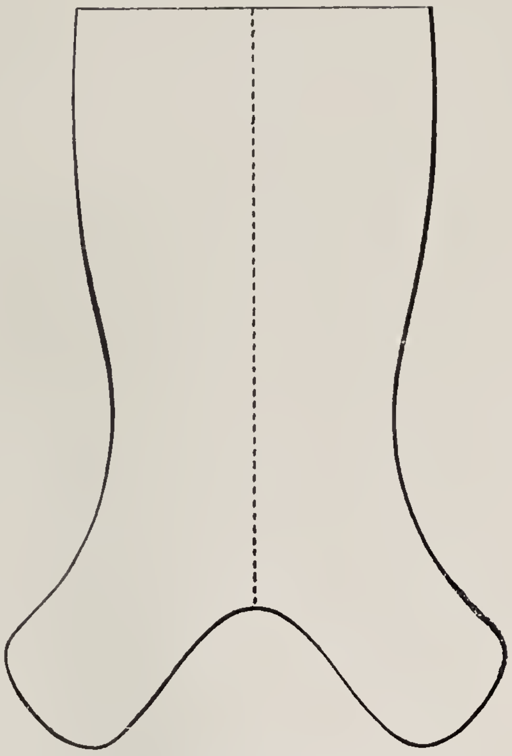

Fig. 836.—Stocking Bivalve Plaster Splint.

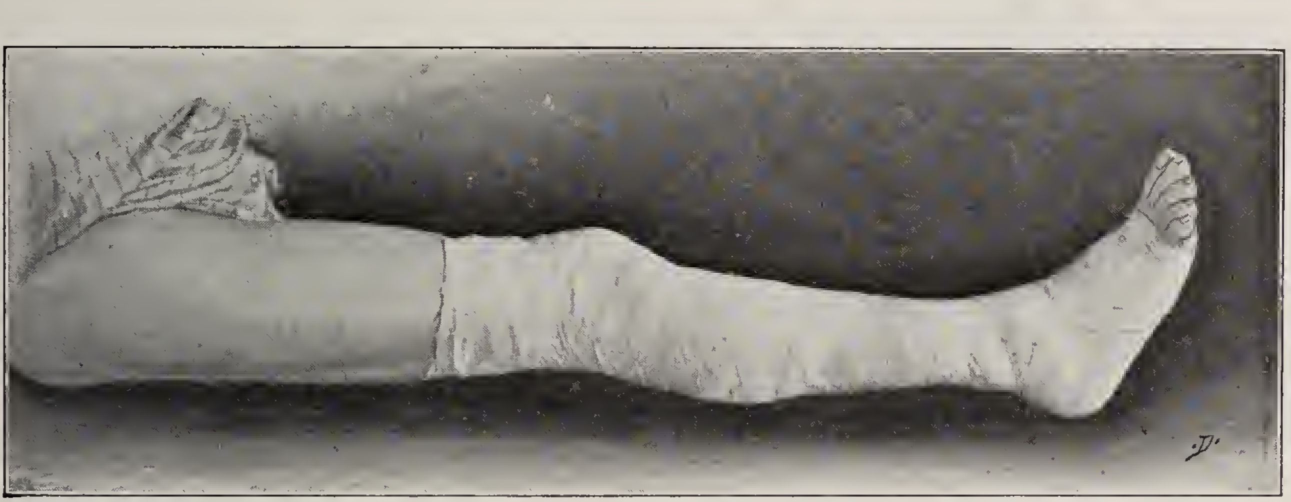

Fig. 837.—Plaster-of-Paris Encasement in Fracture of the Leg.

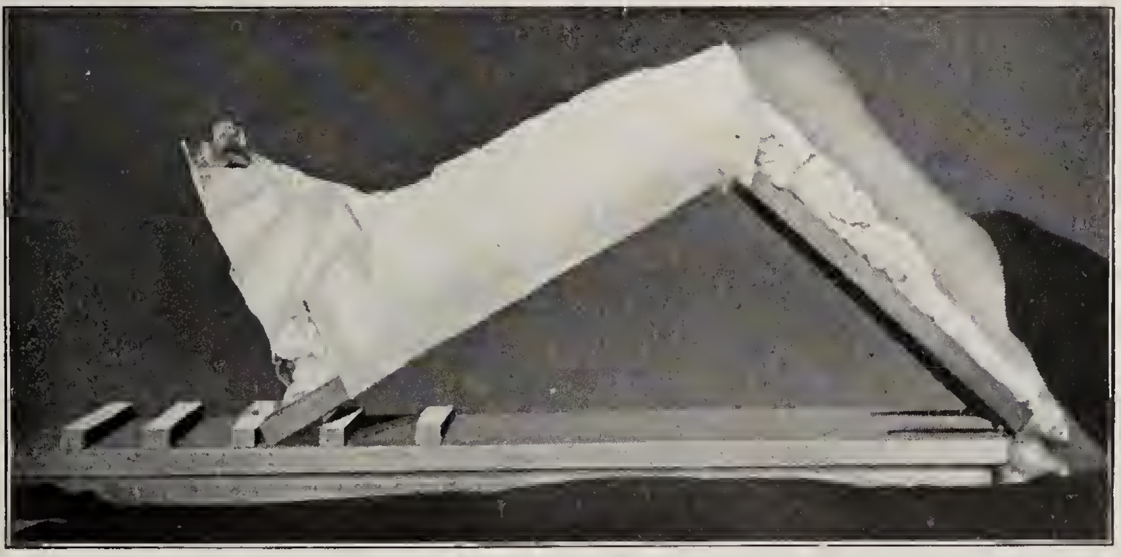

Fig. 838.—Double Inclined Plane.
Sometimes employed in fracture of the leg to overcome persistent spasm and tendency to displacement of the fragments.

necessary. The treatment of the wound is to be carried out on general antiseptic principles.

The claims made for the **ambulatory treatment** of fractures of the leg have not been substantiated. In the construction of an ambulatory splint the aim has been to combine retention by means of a plaster-of-Paris splint with lateral supports, extending well below the sole, which receive the weight of the body through their attachment to the splint. Except in a few selected cases the use of the method is attended with risks of displacement and sloughing from pressure. A case of the latter came under the author's observation. An ordinary hip splint with the limb encased in plaster-of-Paris answers all the purposes of the ambulatory splint, and may be used in cases of fracture of the leg in the later stages of the treatment.

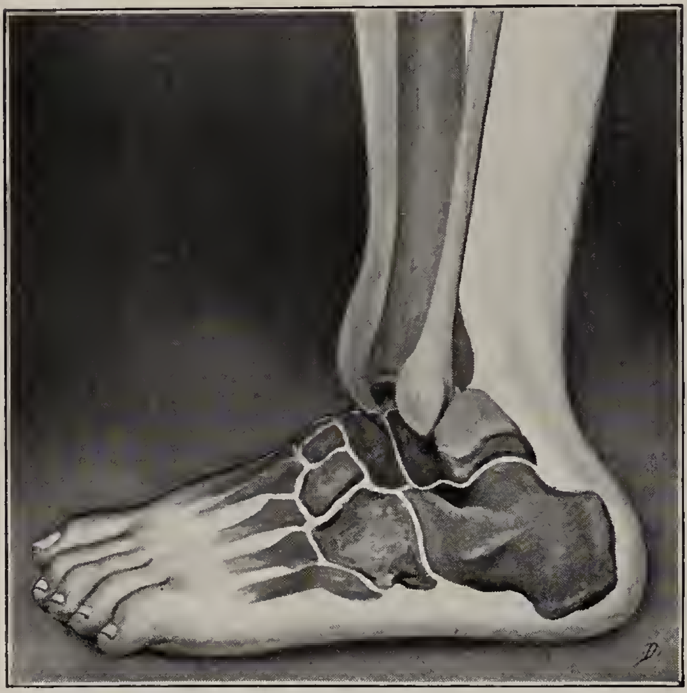
FIG. 839.—DISLOCATION OF THE FOOT BACKWARD.

Dislocations of the Ankle-joint.—Dislocations of the ankle-joint are due to either **forced plantar flexion** or **forced dorsal flexion.** In the case of the former, with sufficient force applied at the posterior edge of the astragalus a fixed point forms at the posterior edge of the tibia; separation of the articular surfaces takes place, and finally the lateral ligaments give way. A secondary movement of dorsal flexion takes place; should this force the joint surfaces together, a severe sprain is the result. If, however, the posterior edge of the tibia slides forward over the smooth edge of the articular surface of the astragalus, the foot is **dislocated backward** (Fig. 839).

The reverse of this takes place in forced dorsal flexion. Extreme muscular tension or rupture occurs as the limit of the normal movement is exceeded, and the anterior edge of the tibia enters the narrow fossa at the anterior edge of the astragalus. The lateral ligaments rupture, and the secondary movement, which here consists of plantar flexion, takes place, so that either the surfaces are brought together again with a resultant sprain, or the anterior edge of the tibia slides over the smooth surface of the astragalus, and the foot is **dislocated forward** (Fig. 840).

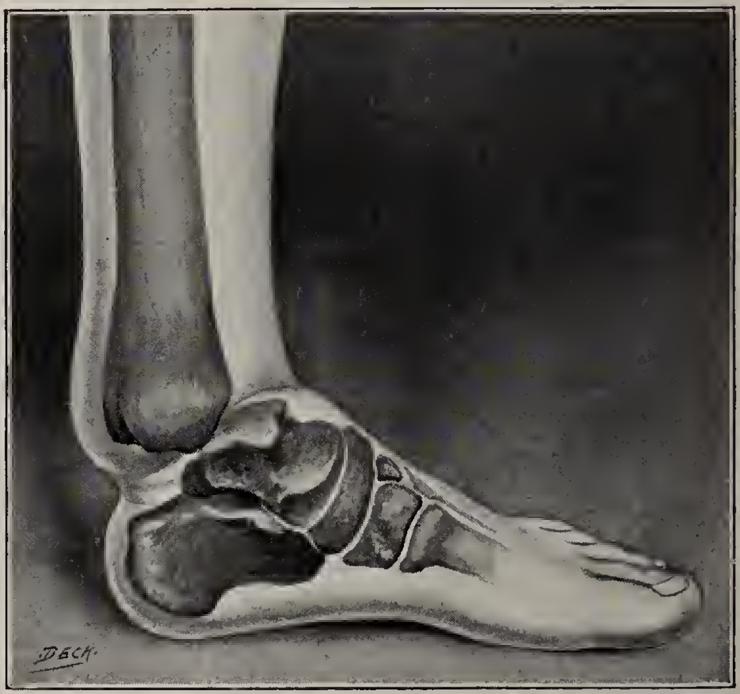
FIG. 840.—DISLOCATION OF THE FOOT FORWARD.

These dislocations are rarely complete, **subluxation** being the rule. This is due to the resistance offered to the sliding movement by the posterior astragalofibular ligament in case of forced plantar flexion, and the anterior astragalofibular ligament in forced dorsal flexion (Hönigschmied). In older individuals the malleoli may be broken.

Hemorrhage and inflammatory swelling take place rapidly, and the characteristic appearances are masked. Comparison with the opposite foot will show an apparent lengthening in case of a forward dislocation, and an apparent shortening in a backward dislocation. The dislocated edge of the tibia can usually be palpated. The foot is in plantar flexion by its own weight, but movements are not greatly restricted. With rupture of the ligaments and the want of symmetry of the opposed surfaces irregular displacements may occur, including rotation of the foot on its longitudinal axis.

Reduction is accomplished in recent backward dislocation by bringing the foot in extreme plantar flexion, drawing it forward, and then carrying it into dorsal flexion. In recent forward dislocations the foot is brought into dorsal flexion and forced backward, the movement ending in plantar flexion. Hueter reduced a total dislocation of six months' standing by this maneuver. In old unreduced dislocations, however, complete reduction is often impossible; the foot is to be placed in as favorable a position as possible. In recent cases, however, simple traction is often sufficient.

The foot and ankle are to be placed in a plaster-of-Paris bandage and kept immobilized for three or four weeks to effect consolidation of the ligaments.

Lateral Dislocations of the Ankle.—Dislocations of the ankle laterally occur only in connection with fracture of one or the other of the malleoli (Fig. 841); the mechanism is the same. **Reduction** and **retention** are also effected in the same manner as in fracture.

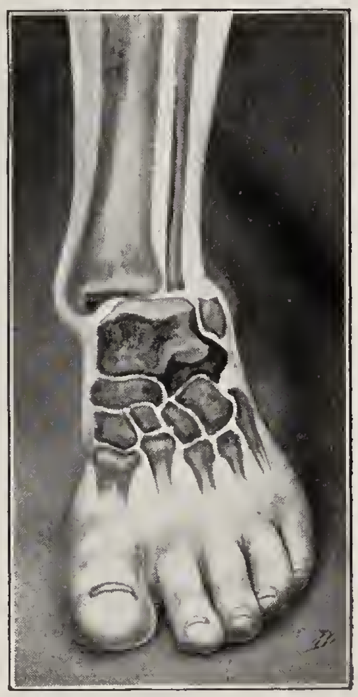
Fig. 841.—Dislocation of the Foot Outward with Typic Fracture of the External Malleolus.

Congenital dislocations occur only as **rotation dislocations,** and are the result of defective development of one of the malleoli (Billroth). Cases of congenital dislocation of both ankles have been observed in several members of the same family (Volkmann).

Subastragaloid dislocations are extremely rare. The astragalus is dislocated from the os calcis at the calcaneoastragaloid joint, and from the scaphoid at the **astragaloscaphoid joint** (Broca, Henke). The dislocation may be inward, outward, forward, or backward. The lateral forms are the more frequent. The inward dislocation arises from forced **adduction** (supination) and inversion, and the outward from forced **abduction** (pronation) and eversion. The latter is the more frequent of the two (13 out of 20 cases, Broca). In inward dislocation of the foot there is inversion, and in outward dislocation of the foot there is eversion. In inward dislocation the neck of the astragalus is sometimes fractured, and in the outward form there is sometimes a fracture of the external malleolus. The most essential protection against dislocation is afforded to the astragalotarsal joint by the presence of the powerful **interosseous ligament** between the astragalus and the calcaneum, and only complete rupture of this ligament permits separation of these two bones. **Reduction** is effected by favoring at first the position of the foot, and, with the leg fixed in flexion, carrying the foot over in the opposite position; at the same time direct pressure is made against the astragalus. Attempts at reduction are successful in less than 50 per cent of the cases. Where the attempt at reduction has proved unsuccessful operative interference is indicated. The object may sometimes be accomplished by chiseling away the head and neck of the astragalus.

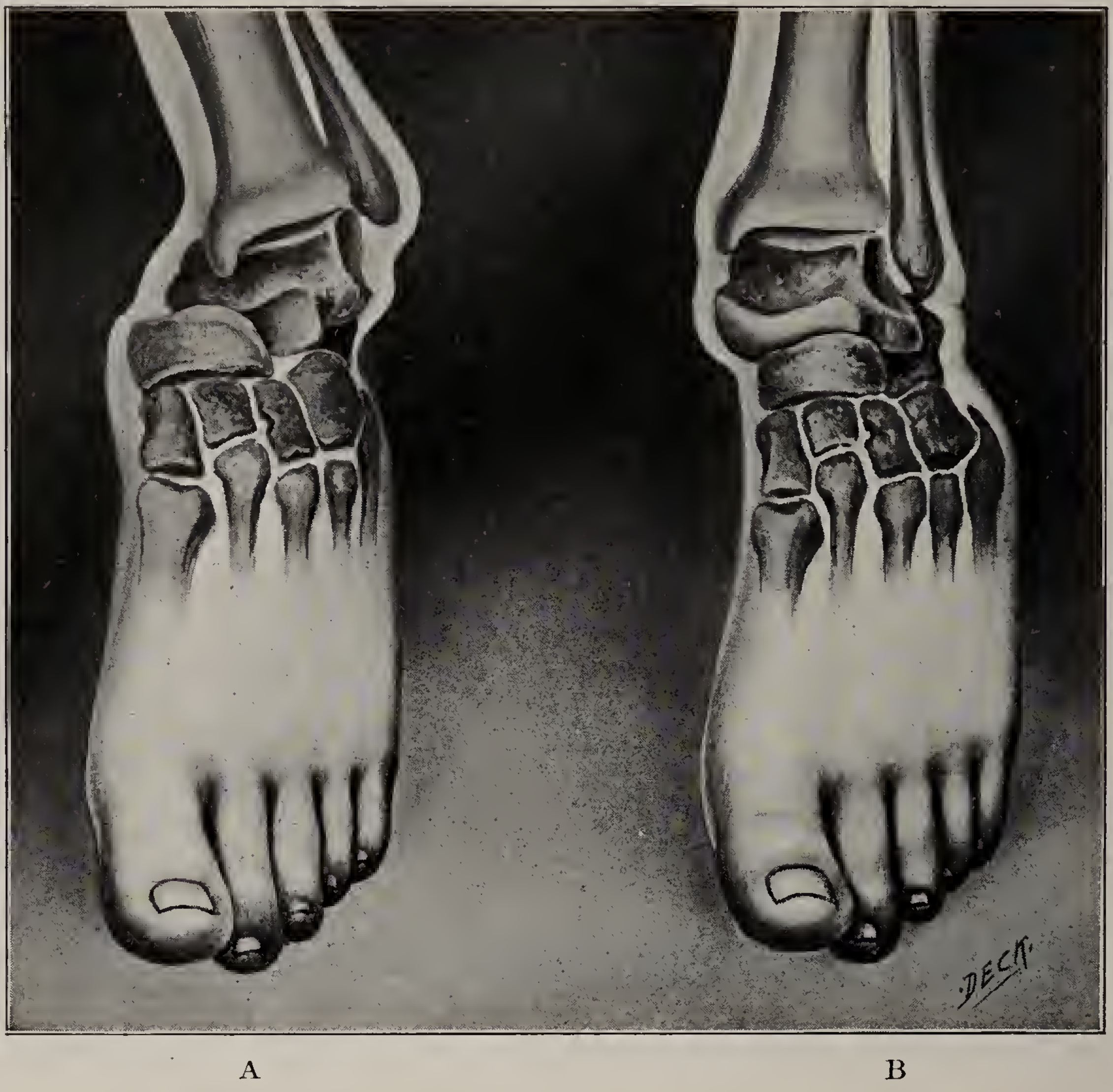

Fig. 842.—A, Inward Subastragaloid Dislocation; B, Outward Subastragaloid Dislocation.

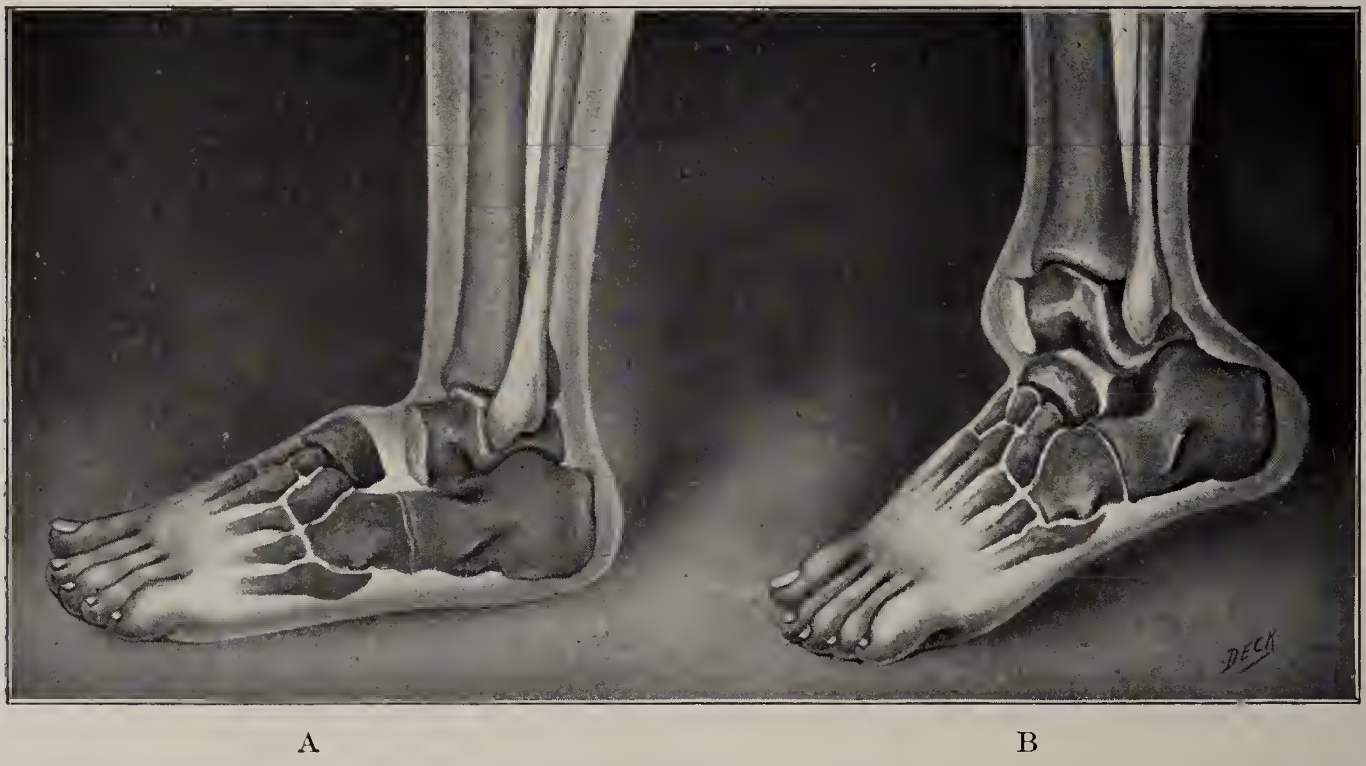

Fig. 843.—A, Forward Subastragaloid Dislocation; B, Backward Subastragaloid Dislocation.

This failing, achillotomy may be performed, or the astragalus may be excised. In cases of long standing with considerable disability it may be necessary to remove both the astragalus and the malleolus.

In **compound dislocation** the dangers of infection and subsequent suppurative inflammation are very great. Primary removal of the astragalus here gives better results than attempts at reduction, even when the latter are successful.

Dislocation of the Astragalus.—By a very rare and complicated effect of extreme forces the astragalus may be dislocated simultaneously at the astragalotibial and at the astragalotarsal joint. It is forced to the dorsal surface of the foot beneath the skin, and perforates the latter, a compound dislocation occurring at once, or else the soft parts subsequently become gangrenous from pressure and the bone is laid bare by sloughing. **Reposition** is rarely accomplished (12 out of 129 cases, Broca) because the space for the bone is taken up by the approximation of the os calcis to the bones of the leg. To permit the bone to remain in its malposition is to invite destructive and septic changes in the soft parts and imperil the safety of the foot. The **indications** for prompt removal of the bone are positive and should be acted on promptly. The results of operation are in every way satisfactory.

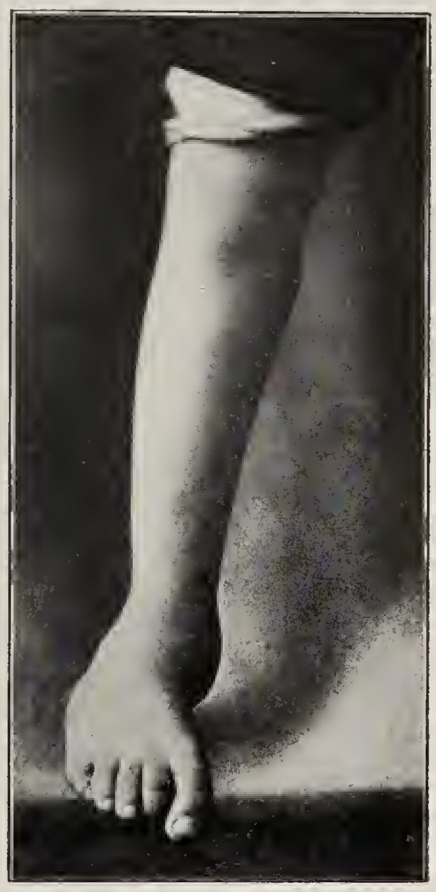

Fig. 844.—Fracture of Astragalus.
Showing the position of the foot.

Fracture of the Astragalus.—The astragalus is usually broken by impingement between the os calcis and the tibia. This commonly results from a fall from a height, or the breaking force may act transversely. The line of fracture may be in almost any direction, or there may be several lines of fracture, dividing the bone in several pieces (**comminuted fracture**). It is probable that many of the supposed cases of sprain of the foot are really cases of fracture of the astragalus without displacement. The **diagnosis** is sometimes difficult, though when both displacement and crepitus exist there should be no difficulty. In doubtful cases the use of the Röntgen rays should clear up the diagnosis (Fig. 845).

The **treatment** is simple in cases in which no displacement has occurred. The foot should be placed in proper position and immobilized with a plaster-of-Paris bandage. Cases with displacement demand early operative

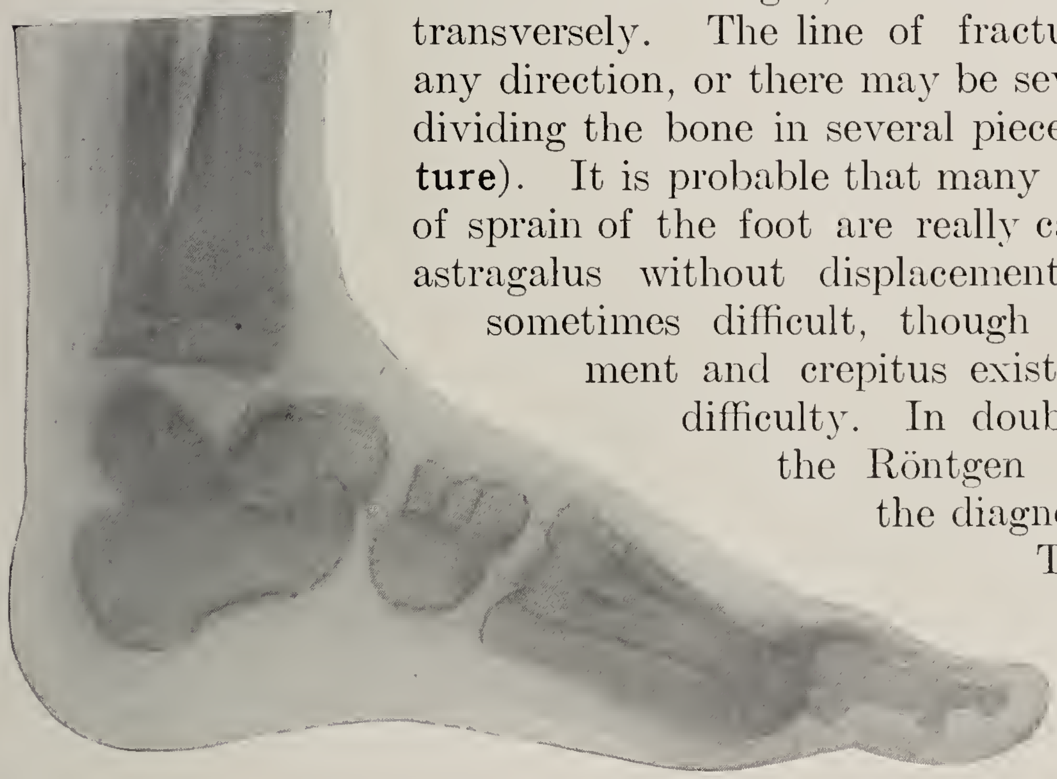

Fig. 845.—Fracture of Astragalus.
From a skiagram of the case shown in the preceding illustration.

treatment, as a rule, on account of the danger of the sloughing of the soft parts overlying the displaced fragment. If a portion of the upper articular surface of the bone has been broken off, the fragment should be removed. Fracture of the neck with displacement of the head will require incision and removal of the head if the latter cannot be replaced. Better functional results are obtained by the removal of detached and displaced fragments than by their retention, even if these could be restored, which is rarely possible. This is still more emphatically true of compound fractures.

Gunshot Fractures in the Neighborhood of the Ankle=joint.—Compound fractures involving the astragalotibial joint are rare. The malleoli as well as the lower end of the tibia may be perforated by a bullet without injury to the joint, particularly in the case of the small-caliber and high-velocity modern arm. In the older type the joints may be involved by splintering, particularly if the missile enters the bone an inch or two above the articular surface, since the bone here splinters more easily. Bullets passing through the astragalus always injure the ankle-joint.

Compound fractures of the mediotarsal or Chopart's joint are also usually gunshot fractures. As a rule, the ball enters at the dorsum, implicates the head or neck of the astragalus, and perforates the tarsal sinus. The same bullet may likewise injure the ankle-joint. Here, also, the consequences of injury to the joint may be separated from those due to the splintering effects. Purely perforative shots are relatively without danger. In the case of the os calcis with its thicker cortical substance, the splintering will usually be greater, and, in case of low propulsive energy, the ball will imbed itself in the bone.

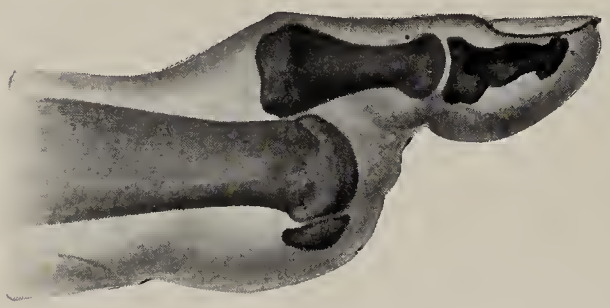

Fig. 846.—Dislocation of Great Toe.

Dislocations of the Tarsal and Metatarsal Bones and of the Toes.—Considerable force is required to rupture the ligaments on the dorsal and plantar surfaces and in the interosseous spaces, in order to permit dislocation of the tarsal and metatarsal bones to take place. Most dislocations occur at the tarsometatarsal joint, in which either all or a part of the metatarsal bones are dislocated. There is neither a special mechanism of origin nor special obstacles to reduction. These dislocations in some respects resemble fractures. **Reduction** is effected by pressure and traction, and retention by a splint, or a simple retentive bandage to prevent redisplacement, such as occurs in a fracture following reduction.

Traumatic dislocations of the toes are very rare, particularly of the four outer toes. Out of 22 cases collected by Malgaigne 19 were dislocations of the great toe on the metatarsal joint (Fig. 846). Both the mechanism of the dislocation and the mechanism of reduction of the great toe are quite analogous to those of dislocations of the thumb. Likewise in many respects dislocations of the toes resemble those of the fingers.

The use of defective foot-gear sometimes leads to displacement of the basilar phalanx so far toward the dorsal side of the metatarsal head that the articular surfaces are no longer in contact. The second toe is the most frequently affected. In addition to the extension of the basilar phalanx, the second and third phalanges are flexed at right angles (**hammer-toe**).

The other toes may likewise be affected; flat-foot is likely to follow. Callosities form on the dorsal surfaces of the toes. The disability is sometimes very great. The **treatment** consists of open transverse division of the skin, flexor tendon, and capsule, combined with excision of the callosities usually present on the dorsal surface, and resection of the joint through the incision made for the excision of the callosities.

Fractures of the os calcis offer special conditions. They are divided into simple **transverse fractures** of the body of the bone near its posterior surface, and **stellate fractures** passing through the body of the bone, the sustentaculum tali, and the anterior process. The former injury is rare as arising from muscular action, though the tendo Achillis may tear off a fragment of bone at its long insertion at the posterior surface of the bone instead of rupturing (fracture by avulsion). Plantar flexion of the foot and flexion of the knee may permit approximation of the surfaces; otherwise tenotomy of the tendo Achillis will be necessary. **Stellate fractures** of the os calcis are more common. They usually arise from falling from a considerable height and striking on the heel with the limb fully extended. The astragalus acts like a blunt wedge on the os calcis. The swelling is considerable, and the effused blood masks the details of the injury; superficial examination usually fails to locate the lesion. The enlargement at each side of the os calcis is resistant, showing an increase in the width of the bone, particularly on the inner side. Movements of the heel are painful, the arch of the tarsus is collapsed and the foot flattened. Broadening of the sole and heel is made apparent by comparing the two feet, with the patient kneeling. The treatment consists in a simple bandage and quiet for four weeks. Disturbances of function are rare; a flat foot, however, results.

Fractures of the other bones of the foot, namely, the cuboid, scaphoid, the cuneiform bones, and the bones of the metatarsus and phalanges, are always due to direct force, such as the falling of heavy bodies on the feet, crush accidents, gunshot injuries, etc. The latter are common in military practice. Their importance is due more to the injuries of the soft parts than of the bones. Projectile injuries, wounds from fragments of shells, etc., are more important because of the usual coincident opening of the tarsal joints, and the later occurrence of suppuration and caries. Extensive resections, and even amputations, are very often required in these cases.

Injuries of the Muscles and Tendons of the Leg and Foot.—Among the injuries of the soft parts of the leg and foot those of the muscles, tendons, and sheaths of the tendons are the most important. These tendons are occasionally ruptured subcutaneously, specially those of the muscles of the calf, the tendo Achillis, and the peroneal tendons. Small rents in the calf muscles are sometimes observed; these arise from excessive exertion, as in jumping, or they may occasionally occur spontaneously from muscular cramps, which are here very frequent. These muscular cramps are frequently caused by varicose veins within the muscles (Hueter). The violent pains in cramp of the muscles of the calf are due to compression of the communicans poplitei where that nerve descends to join the communicating branch of the peroneal. Special treatment is not necessary; the condition requires simply rest.

Transverse rupture of the tendo Achillis above or at its point of attachment, with or without fracture by avulsion of the os calcis at the point of insertion, sometimes occurs in consequence of powerful contraction of the muscles of the calf. In two cases coming under my observation the injury occurred from forced dorsal flexion of the foot, with coincident direct pressure on the tendon. The tendon gave way as a tense violin-string gives way when struck a quick blow. In the first case the patient, an officer in the Revenue Service, sprang from the pilot-house to the deck of a tugboat and struck with his foot in dorsal flexion, forcing it into a narrow space between two boxes. The sharp edge of one of the boxes impinged on the tendo Achillis, which gave way with an audible snap. In the second case an army teamster was thrown from his seat by a runaway team and struck with his heel forced between two rough logs. The foot was strongly flexed in the dorsal direction, and it became necessary to roll the logs apart to extricate it.

In rupture of the tendo Achillis the patient feels as if struck by some blunt weapon, and as if his heel were sunk into a hole. A hollow exists at the place of rupture. He may be able to produce plantar flexion by means of the intact plantaris and the tibialis posticus, but cannot, while standing on the injured side, raise the body by lifting the heel from the ground. The **treatment** is immediate suture, when possible. The parts at the site of the rupture should be exposed by a lateral curved incision, the clots turned out, and accurate coaptation maintained by means of fine silk sutures, the foot being held in strong plantar flexion and the knee well flexed. The external wound is sutured and a plaster-of-Paris bandage applied. If the ends cannot be approximated within an inch, the os calcis may be exposed by a U-shaped incision and sawed through in a vertical direction so as to allow the posterior fragment with the lower ruptured end attached to be displaced upward (Poncet). Or, the upper end may be lengthened by the operation of splitting and reflecting the partially detached segment downward (see Operations on Tendons). Failure to approximate the ends, or any portion thereof, may necessitate the attachment of the central end to the tendon of the tibialis posticus.

Rupture of the plantaris muscle cannot be diagnosed with certainty, and is of no surgical importance.

Dislocations of the peroneal tendons from their normal position behind the external malleolus, and **dislocation of the tendon of the tibialis posticus** on the external malleolus, are rare injuries, the latter particularly so. These injuries occur from rupture of the tendinous sheaths, and the dislocation takes place as a habitual dislocation when the muscles are contracted. Where there is much disability, and when after-treatment by compresses designed to hold the tendon in place has failed, the tendon may be replaced by means of an operation designed to suture the torn tendon-sheath, and to form a new one from the adjoining fascia; this is supplemented by chiseling a groove for the tendon behind the malleolus.

Hemorrhage into the peroneal sheaths and also **into the sheath of the tibialis posticus** has been observed and is not very rare. The hemorrhage may be followed by synovitis and **dropsy of the sheath of the tendon.** In differentiating this condition from accumulation of fluid in the ankle-joint the point to be borne in mind is that when the fluid is in the joint the swelling appears in front of the malleoli, while, if it is in the sheath of the peroneal tendons, or the tendon of the tibialis posticus, it will appear behind the respective malleolus. The **treatment** is by **massage and compression.** Phlegmonous inflammation travels along the sheaths of the tendons of the toes in a manner similar to that described in connection with the hand and fingers. In cases of injuries of the soft parts suppuration must be controlled, and early free exit given to suppurative collections, particularly in the sole of the foot where these occur beneath the dense plantar fascia.

Hemorrhage and serous and tuberculous synovitis have been observed in the joint-like **sheath of the peroneus longus** where it passes over the cuboid bone to the plantar surface of the foot.

Injuries of the Nerves and Vessels of the Leg and Foot.—Superficial wounds may divide the **saphenous nerve,** sensibility at the inner edge of the foot to the great toe being destroyed. At the dorsum of the foot the same nerve may be injured, as well as the cutaneous branches of the musculocutaneous and those of the anterior tibial. The loss of sensibility from these injuries is unimportant. The two principal nerves of the leg and foot are the **peroneal** and the **tibial.** Of these, the former is much more exposed to injury than the latter, on account of its more superficial location just below the knee-joint, at the point where it passes from the popliteal space around the head of the fibula to the anterior surface of the leg. The majority of injuries of this nerve recorded were caused by the scythe while mowing. Injuries of the main trunks of the peroneal and tibial are followed by disturbances of motion as well as of sensation. Gunshot wounds, as a rule, affect in addition the accompanying artery, the anterior or posterior tibial, and the bone; under these circumstances the injury to the nerve is unimportant. The rare cases of exclusive injury to the nerve as occurring from punctured or incised wounds, *e. g.*, operation wounds, will therefore be considered.

The areas of innervation of the two large nerves of the leg are definitely separated. Division of the peroneal nerve paralyzes the abductor muscles of the foot, and gives rise to the appearances of clubfoot (talipes equinovarus), without the contractures of the adductors. The foot, therefore, in walking, falls into position by its own weight and the patient is able to walk on the sole of the foot (Hueter, Langenbeck). (For nerve suture, see page 354, Vol. I.)

The **arteries** of the leg are injured rather frequently, but almost always in connection with injuries of the bone. Simultaneous injury of both arteries may be followed by gangrene of the foot. If amputation is not otherwise demanded, local ligation of the arteries is indicated. In cases of secondary hemorrhage due to local septic conditions ligation of the femoral artery in continuity may be preferable to local ligation of the deep arteries in septic and inflamed tissues.

Both trunks of the tibial arteries are so accessible at the tarsus that the control of hemorrhage is not difficult. Hemorrhage from the terminal branches of the tibial arteries at the metatarsus and the plantar arch is rare and is usually controlled by local ligation.

Hemorrhage from varices is sometimes sufficiently serious to lead to death (see Vol. I, page 101). Direct compression usually suffices for its arrest.

Ligation in Continuity of the Anterior and Posterior Tibial Arteries.—**Typic ligation of the anterior tibial artery** in continuity is performed in the lower third of the leg above the ankle-joint. A 3-inch longitudinal incision is made through the integument between the tendons of the tibialis anticus and the extensor proprius hallucis (Fig. 847, *a*). The crural fascia is divided for the length of the skin incision and the space between the tibialis anticus and the extensor proprius hallucis recognized, the muscles separated to the interosseous ligament, and the peroneal nerve identified (Fig. 848). The artery lies behind the nerve, and to the inner side of it, surrounded by two or more veins. The **dorsalis pedis** artery is ligated in front of the ankle-joint. The incision is made parallel to the tendon of the extensor proprius hallucis and to the outer side of it (Fig. 847, *b*).

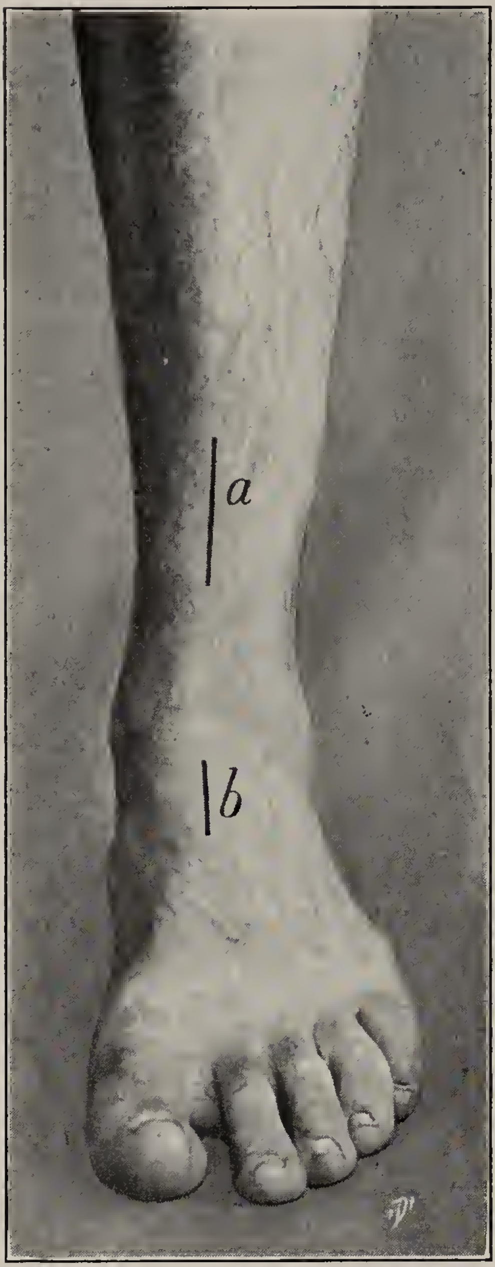

Fig. 847.—Incisions for Ligation of (*a*) the Anterior Tibial Artery, (*b*) the Dorsalis Pedis.

The **posterior tibial artery** is ligated in the middle third of the leg, through a 3-inch incision, a fingerbreadth internal to the median border of the tibia (Fig. 849, *a*). The crural fascia is divided at the edge of the tibia; the inner insertion of the soleus is separated from the bone, when the interval between the superficial and the deep group of calf muscles occupied by loose connective tissue comes into view. The soleus and gastrocnemius muscles are lifted from their bed with a blunt retractor. The layer of fascia separating the deep group of muscles from the soleus is divided to the first intermuscular space between the flexor longus digitorum and the tibialis posticus muscle, when the posterior tibial artery, accompanied by the posterior tibial nerve and several veins, is found.

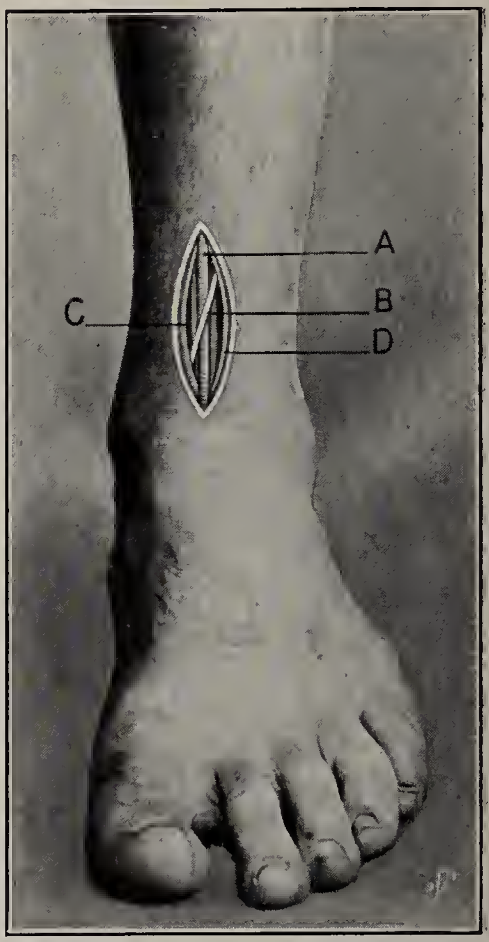

Fig. 848.—Relation of Tibial Artery to Peroneal Nerve (Hueter).

A, Anterior tibial artery; B, peroneal nerve; C, tibialis anticus muscle; D, extensor proprius hallucis.

In **ligation of the posterior tibial artery** behind the internal malleolus the inner lower edge of the latter and the inner lower edge of the plantar surface of the os calcis (not the edge of the soft parts of the heel) are identified. The artery lies in the middle of the space thus marked out. With the foot well rotated outward a curved incision with its convexity upward and forward is made at this point (Fig. 849, *b*). The upper end of this incision lies midway between the point of the malleolus and the median border of the tendo Achillis. The fibrous fascia is divided across; the artery, accompanied by two veins, comes into view.

The lower third of the leg is sometimes selected for the ligation. A 3-inch incision is made parallel to the inner margin of the tendo Achillis, and the two layers of fascia divided. The artery with its venae comites is found on the outer margin of the flexor longus digitorum, the nerve lying external to it.

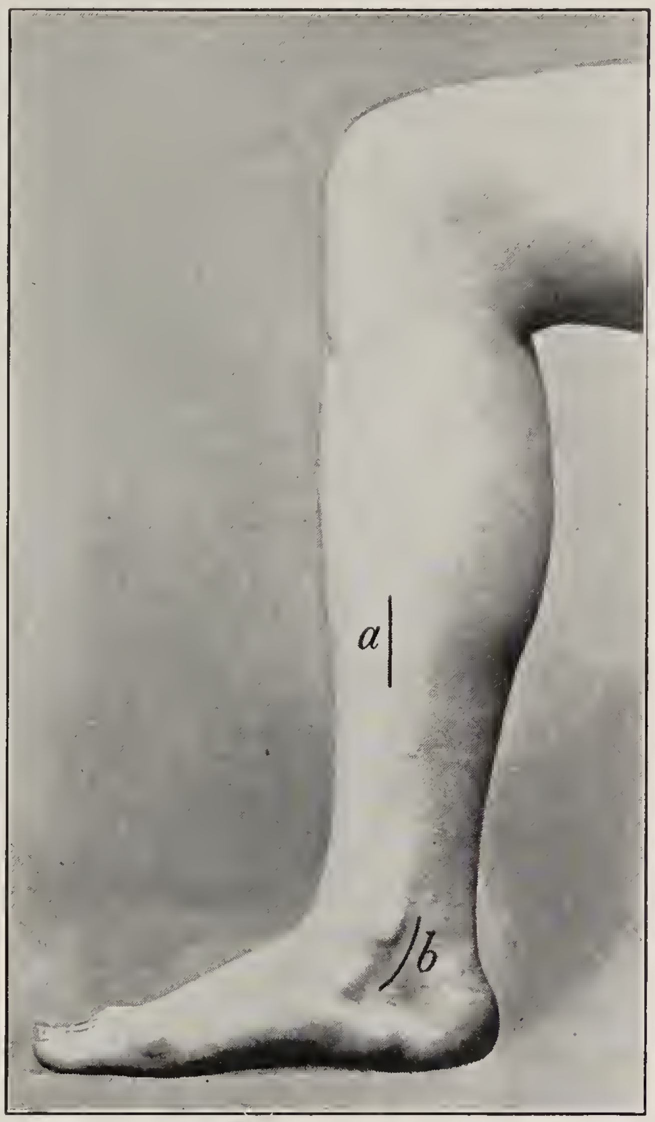

Fig. 849.—Lines of Incision for Ligation of Posterior Tibial Artery (*a*) in the Middle Third of Leg, (*b*) behind the Internal Malleolus.

INFLAMMATION OF THE SKIN OF THE LEG AND FOOT

Acute inflammatory processes in the leg, *e. g.*, **lymphangitis, cellulitis,** and **erysipelas,** are often due to ulcers and trivial wounds on the toes or at the edges of the nails. They are to be treated on general principles (see Vol. I, page 177). **Furuncles** and **eczema**, which at first appear harmless, without proper treatment may undergo **ulceration** under the influence of embarrassed circulation in those whose occupation compels them to stand a long time.

Callosities and **blisters** occur in consequence of shoe pressure. The callosities sometimes become very painful, so that removal with the knife is necessary. Blisters should be simply pricked with a sterilized needle after thoroughly cleansing the surroundings, and the contents evacuated. They should then be firmly strapped with strips of adhesive plaster, the strips extending several inches beyond the margins in all directions. These should be allowed to remain for several days before removal. The strapping may be repeated, if necessary. Fissures of the callosities and rupture of blisters sometimes lead to infection of the papillary body. The sole of the foot is predisposed to the same form of phlegmonous inflammation as the palm of the hand, but it is not so frequently exposed to infection except in those who go barefooted (see Panaritium of the Hand; for treatment of corns, see Clavus).

Ingrowing toe-nail (unguis incarnatus) is a very common affection. The nail does not grow into the flesh, however, but the skin of the nail-fold encroaches on and envelops the nail. The affection originates from simple **onychia,** an inflammation of the nail-fold and matrix. Slight traumatism, due to improper cutting of the nail, or lateral pressure from a deformed nail, permits infection in unclean conditions, the microorganisms proliferating in the soft epidermal layer of this furrow. Inflammation of the papillary body and suppuration follow, and **granulations grow about the edge of the nail** (Fig. 850); pus is confined between the granulating surface and the nail. In the treatment of ingrowing toe-nail it has been recommended to paint the ulceration, in the initial stage, with a solution of ferri chloridum. Operative treatment must be resorted to in old and severe cases. The simplest plan is to split the nail in the middle with a pair of stout scissors, remove one or both halves, curet or cut away the granulating tissue and adjacent matrix and nail furrow, and dress antiseptically.

Onychia maligna (Wardrop), in which the whole of the matrix is involved in the inflammation, requires entire removal of the matrix. This affection may be syphilitic or tuberculous.

All suppurative inflammations of the leg and foot should be treated by early incision, on account of the danger ensuing from necrotic conditions, such as ulcer, etc., due to the defective nutrition of these parts.

Perforating ulcer of the foot (**mal perforant du pied** of Vésignié), or **Madura foot,** is a peculiar ulceration of the sole of the foot which penetrates from the skin through the plantar aponeurosis and the muscles and tendons toward and through the space between the metatarsal bones. It may be due to endarteritis obliterans, and is analogous to senile gangrene. Again, it may result from neglected panaritium, epithelial carcinoma, or suppuration of deep bursae mucosae. In other cases it originates from diabetes mellitus, or it may have a neuropathic origin, with paralysis of sensory and vasomotor nerves. Ergot poisoning may cause gangrene of the toes. Perforating ulcer of the foot frequently commences at the site of a corn. The treatment consists of rest in bed, wet antiseptic dressings, and removal of the loosened tissues each day. When the ulcer becomes healthy, it is treated by glycerin to which sufficient salicylic acid is added to make a cream; to each ounce of the cream, 10 minims of carbolic acid are added. After it has healed all pressure is to be removed by wearing a bunion plaster. Excision of the ulcer, or even amputation, may have to be resorted to in recurring cases.

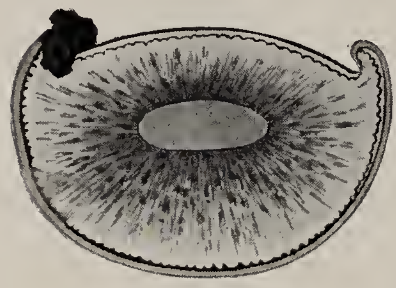

Fig. 850.—Transverse Section through Phalanx of Great Toe (after Hueter). Showing ingrowing toe-nail and mass of granulation tissue.

Decubitus (**bed-sore**) may occur at the heel from lying in bed in cases of paralysis, as, for instance, after injuries of the spinal cord. Antiseptic dressing is the best treatment.

Varicose Ulcers.—Varicose ulcers commonly make their appearance on the leg and about the ankle. They are more frequently observed in the class of cases in which there is more or less thickening of the skin from exudate both in this structure and in the subcutaneous connective tissue, and in which the prominence of the veins is masked by the exudate and the accompanying edema. The resulting disturbances of nutrition are frequently followed by an obstinate eczema, which in time gives rise to superficial ulceration. This becomes chronic, and eventually extends both in area and in depth, ultimately involving the entire thickness of the skin. A varicose ulcer may likewise arise from an abscess following a **suppurative thrombophlebitis** if this is permitted to implicate the skin; if incised early, however, this does not occur.

In the **ambulatory treatment** of chronic varicose ulcers the thickened edges and hard fibrous floor of the ulcer are to be incised by parallel incisions about one-fourth of an inch apart, which should include the thickness of the indurated edges and floor, and should extend about half an inch or more into the surrounding tissue ("gridiron incisions"). The blood-clot which forms in these incisions is permitted to remain when the bleeding has ceased. A thorough antiseptic cleansing of the surroundings should precede the incisions.

To relieve the hyperemia and at the same time protect the ulcer and support the circulation, so that the patient may be up and about, there is no measure so efficient as basket-strapping with resin or diachylon plaster. The plaster should be cut crosswise to the piece and three-fourths of an inch wide. Heating over an alcohol lamp increases the adhesive qualities of the plaster, and at the same time sterilizes it (see page 71, Vol. I).

Subfascial phlegmon is most frequently due to open wounds of the soft parts, the infection extending to the deeper structures; or it may result from subcutaneous phlegmon. The last named occurs most frequently at the dorsum of the foot; it is rarely observed in the sole on account of the dense and slightly vascular plantar aponeurosis, and the short and vertically placed fibers of the latter. The occurrence of phlegmonous inflammation beneath the plantar fascia, however, is followed by high fever and other grave constitutional disturbances, owing to the pressure of the dense fascia, which compels rapid absorption. The condition demands prompt interference in giving exit to the pus and maintaining free drainage.

Senile gangrene rarely occurs before the seventieth year, and is more frequently observed in men than in women. It begins almost constantly at the great toe, where it is favored by defective nutrition arising from the distance of the latter from the heart, as well as by endarteritis obliterans. It begins as a brownish discoloration, sometimes accompanied by vesicles containing serum. The skin becomes black, the discoloration extending to the base; the same changes may go on in the other toes as well. Pain is present from the beginning. After the blisters are opened the tissues become dry or mummified from defective arterial pressure. At the margins of the gangrenous portions the tissues still contain sufficient moisture to cause putrefaction, and to infect the still living adjacent tissues. The resulting inflammation occasionally affects the surrounding tissues as a subfascial phlegmon, and may endanger life from septic absorption. The subsequent course of the gangrene varies greatly in different cases. In some cases death occurs within a few weeks after the first appearance of the gangrene, while in others the gangrene extends, with low fever, from the toe to the metatarsal region, and upward to the leg, the patient after months of suffering succumbing to chronic septicemia. These patients frequently suffer from valvular disease of the heart, diabetes, chronic nephritis, and other disturbances, from which they may perish in the meanwhile. Hypostatic pneumonia, bronchitis, and uremia frequently hasten the end.

Frost=bite occasions a like condition of gangrene. There is this difference, however: in frost-bite, amputation may be followed by a very good result in otherwise healthy individuals and in cases in which the dead tissues have separated from the living by processes of suppuration and granulation (**line of demarcation**). Even in this class of cases there may be highly inflamed tissues and a profound general septic infection, when the prognosis is not so favorable, though intermediate amputation is frequently successful.

In senile gangrene, on the other hand, even with moist antiseptic dressings, general stimulating treatment, elevation of the foot and warm baths, a line of demarcation is seldom formed. Amputation, therefore, must be performed at a sufficient height to reach tissues the temperature of which is not lower than that of the corresponding part of the other limb. Amputation below the tubercle of the tibia is only rarely successful. High amputation is most often successful for the reason that the deep femoral artery is rarely attacked by atheroma, and may nourish the flaps. In the majority of cases either the lower third or the middle of the thigh should be selected.

Moist or **acute gangrene** differs from the dry senile form in that the part remains moist and putrefaction occurs. It may be limited to parts actually destroyed by traumatism, which, together with some surrounding tissue, die, or it may tend to spread widely from virulent specific microorganisms, this resulting in strangulation of the vein or artery, or both (Nancrede). In the typic form of moist gangrene both the vein and the artery are constricted or damaged. When occurring as a result of inflammation, the pressure of the exudate cuts off the blood-supply. The treatment, pending the formation of a line of demarcation, consists in dressing the parts antiseptically. Amputation should be performed well above the gangrenous parts.

INFLAMMATION OF THE BONES OF THE LEG

The shaft of the tibia and the lower end of the femur are attacked with about the same frequency by **acute osteomyelitis. Sequestrotomy** is therefore quite often necessary in the shaft of the tibia. The operation is comparatively simple, however, from the superficial location of the anterior surface of the bone, where the infection usually tends to point.

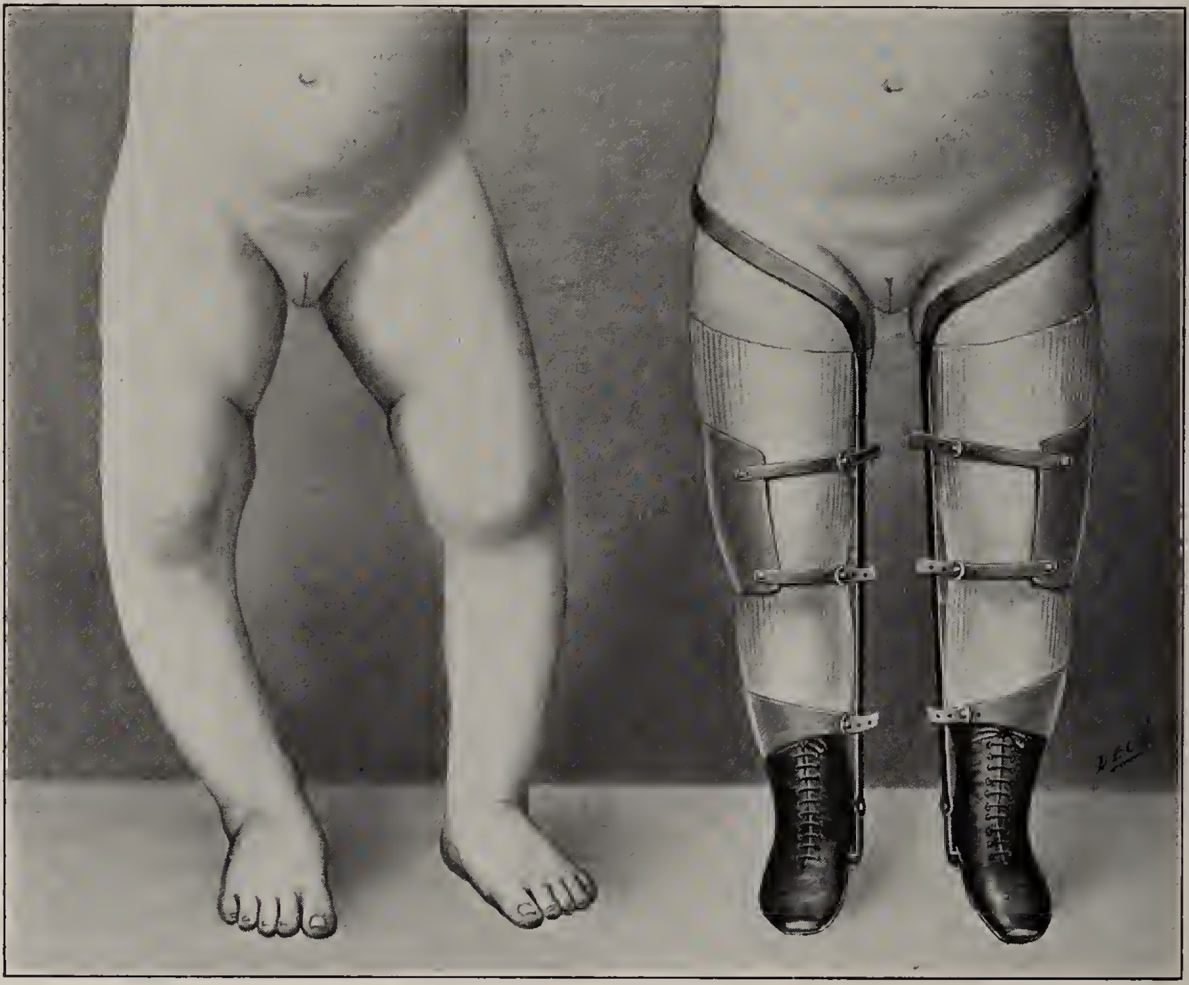

Fig. 851.—Bow-legs and Brace Applied.

Bone abscesses have a peculiar disposition to occur at the upper and the lower end of the tibia. The majority of these are tuberculous; occasionally they are due to the breaking down of **syphilitic gumma of the bone**, syphilitic affections of the tibia being rather common. Severe nocturnal pain with swelling in the upper or the lower end of the tibia and the occurrence of fever point to the existence of bone abscess. An exploratory drilling operation may reveal the presence of pus, in which case free vent must be given by the chisel, and the opening enlarged sufficiently to permit thorough cleansing with Volkmann's sharp spoon. **Acute osteomyelitis** is occasionally, though rarely, observed in the fibula. A total sequestration of the bone has been observed, requiring the removal of the entire bone.

Rachitic Curvatures of the Leg.—Rachitic curvatures are frequent in the lower third of the leg (Fig. 851). The convexity of the curve is usually directed outward, occasionally forward, rarely inward. The bone is usually flattened from side to side. A curvature may be present near the upper epiphysis of the tibia, and a similar one in the lower end of the femur (**genu varum or bow-leg**). In children between two and six years the treatment consists of antirachitic measures (see Rachitis, page 144, Vol. I), and the use of braces (Fig. 851). In children between six and eight years of age the bone can frequently be straightened simply by the hands, with the patient under an anesthetic. This may be done even at an earlier age if the curvature is pronounced. Cases resisting simple manual straightening may be corrected by the osteoclast (Fig. 852), or by weakening the bone at the desired point by a few nicks of the chisel, or one or two drill-holes. After sclerotic changes have occurred in the later years of childhood, and in adults, it will be necessary to remove a wedge-shaped piece of the bone.

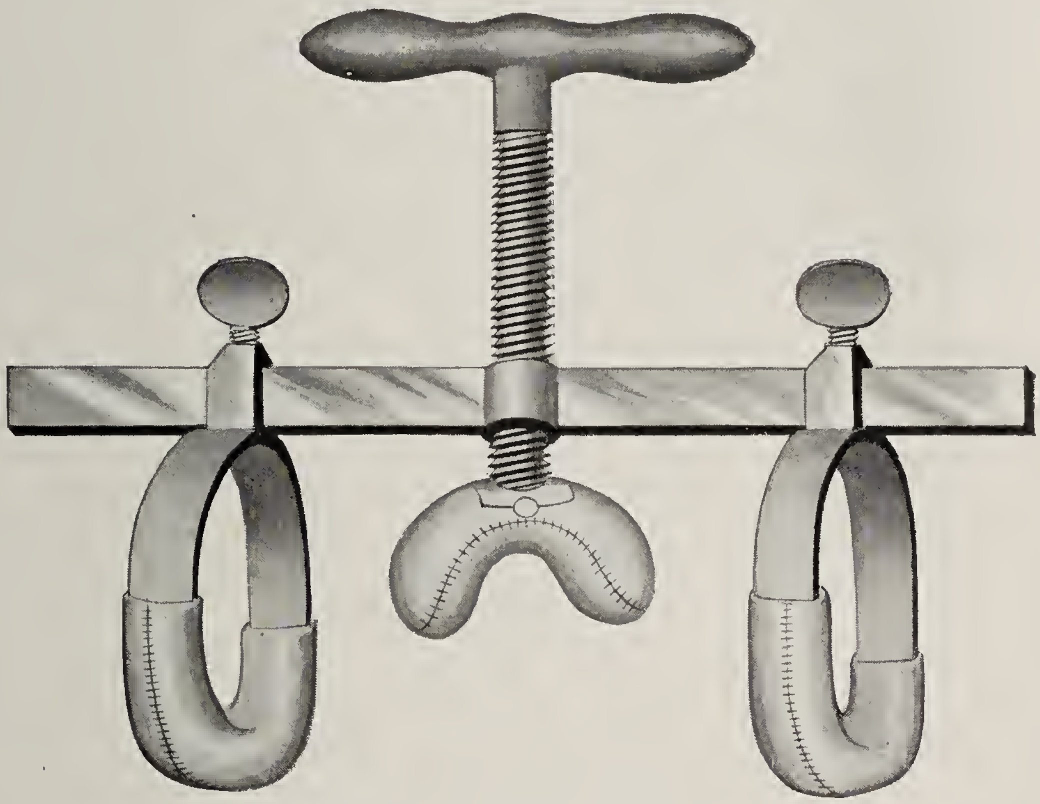

Fig. 852.—The Osteoclast.

Non-traumatic Inflammation of the Ankle-joint.—This may occur in the acute or the chronic form of **polyarthritis**. The occurrence of **tuberculous arthritis** in otherwise apparently healthy children is sometimes preceded by what appears to be a simple serous synovitis, with perhaps rather more swelling in the periarticular tissues than occurs in the latter affection in other joints. Suppuration follows, and death may take place from miliary tuberculosis. In other cases, as well as in adults, the tuberculous synovitis is a manifestation of a general tuberculosis.

In the majority of cases the tuberculous synovitis follows a more chronic and localized course, extending from the synovial membrane to the bone. Isolated foci in the bone are uncommon; the spongy tissue of the lower end of the tibia becomes the seat of a diffuse tuberculous osteomyelitis, resembling more an inflammatory osteoporosis than a tuberculous process. The bone feels spongy on pressure; this also elicits tenderness, which extends an inch or more above the joint. This sensitiveness of the tibia is peculiar; it may be present when there are very slight changes in the joint itself.

Primary inflammation of the bone is rare at this point, and still rarer is primary tuberculous osteomyelitis of the malleoli or lower epiphysis of the tibia. A tuberculous focus in the astragalus is, however, less rare, though this bone is not specially prone to tuberculous disease. Usually the disease originates in the adjacent tarsal bones, which are much oftener affected primarily with this disease than is the astragalus.

The **diagnosis of inflammation** of the ankle-joint depends on the accumulation of fluid in the joint, and its strict limitation to the joint capsule, unless the perisynovial structures are involved. The presence of the fluid may be made out most distinctly where the ligamentous structures are absent, namely, at the anterior margins of the malleoli, particularly at the external malleolus. In case the perisynovial tissues are involved, as occurs in the more advanced form of the disease, the swelling may appear beneath the tendinous structures anteriorly and even in the neighborhood of the tendo Achillis (**tumor albus pedis**). Swelling *behind the malleoli* is due to affections of the peronei and posterior tibial muscles, while that due to ankle-joint disease is *in front of the malleoli.* Passive movements of adduction (supination) will effect tension on the peroneal sheaths and produce pain, the ankle-joint not being affected. **Plantar** flexion to a midway position (pes equinus) is present in ankle-joint disease; it enables the patient to secure a comfortable position of the foot, by giving a larger capacity to the joint for the accumulated fluid. This is a characteristic symptom in inflammation of the ankle-joint.

Palpation may determine the presence of fluid if the accumulation is large, otherwise not. Even with a large amount of fluid in the joint this symptom is not usually available, owing to the presence of the flexor tendons. In case of destruction of the ligamentous structures it is sometimes possible to move the foot backward in the mortise between the tibia and the fibula.

Fever is not usually a marked symptom as compared with analogous inflammatory conditions of the knee-joint and hip-joint, on account of the small absorbing synovial surface of the membrane and the relatively slight pressure to which the pus is subjected.

The pain is greatly aggravated by standing on the foot, particularly after the articulating surfaces have been denuded of their cartilage, or when the process has extended into the bone. The patient walks by fixing the ankle-joint and walking on the base of the toes.

The course of the disease is more favorable in children than in adults, since the introduction of antituberculous injections into the joint and treatment by the thorough scraping away of the infected tissues (**synovectomy** or **arthrectomy**).

In case of recovery the **functional prognosis** is not specially unfavorable. If care is taken in the treatment to **preserve the foot at a right angle to the axis of the leg,** recovery with ankylosis gives a very useful foot. The **vital** prognosis in cases in which miliary tuberculosis supervenes has already been considered.

Treatment of Inflammations of the Ankle-joint.—The application of ice is particularly efficient in acute inflammation of the ankle-joint for the reason that the synovial membrane is quite readily accessible at the anterior aspect of the joint, with the foot in dorsal flexion. In severe injuries and in acute traumatic suppurative inflammation of the joint the ice lessens not only the pain but also the intensity of the inflammation. In chronic inflammation the warm bath is preferable, to which salt may be added. The bath should be used with the patient lying down, a special three-cornered basin resting on a wooden frame being employed. In severe cases the joint must be fixed in a right-angled position with plaster-of-Paris, and this kept elevated. Suppuration following fracture of the joint always indicates resection; in no other way can sufficient drainage be secured. Amputation may finally be demanded.

The treatment of tuberculous disease of the ankle-joint must conform to the general principles of treatment for this disease as occurring in the knee-joint. The injection of from a half dram to two drams of 10 per cent iodoform in glycerin, according to the age of the patient, after evacuation of the contents of the joint cavity either by simple puncture or by incision, as in tuberculous disease of the knee-joint, is recommended. The injections are best made anteriorly on both sides of the extensor tendons. In suppurative cases thorough evacuation by free incision, scraping out of the joint, and drainage, supplemented by pure carbolic acid applications followed by the neutralizing effects of 95 per cent alcohol, are to be practised. In cases advanced to caries, **arthrectomy** or **atypic resection** may be employed. Complete resection should be avoided in children, whenever possible, but it may be performed in adults when necessary. The astragalus is excised if diseased. In advanced or severe cases with nephritis, a tuberculous diathesis, or amyloid degeneration, it will be necessary to amputate. The osteoplastic resection of Mikulicz-Wladimiroff is useful in some cases. Constitutional treatment by means of nourishing foods, pure air, and the use of salt-water bathing or marine salt baths at home should not be neglected.

Inflammations of the Astragalotarsal Joints.—Acute inflammation of the synovial cavities between the astragalus and the os calcis, and between the astragalus and the scaphoid, is not often observed except in case of open wounds; of these, gunshot wounds are the most common, in which the ankle-joint is injured as well. Chronic inflammation in this region is due to tuberculous disease in the great majority of cases. This almost invariably commences as an osteomyelitis of the astragalus; the os calcis and the scaphoid are sometimes, though rarely, primarily involved. **Primary tuberculous synovitis** of these joints is not observed. The disease may spread from the astragalotarsal joints to the adjoining tarsus, with final extensive destruction of the latter. In the cases in which the primary focus is in the os calcis, this may break through externally without involving the neighboring joints. **Acute (non-tuberculous) osteomyelitis** of the os calcis is likewise observed in which central necrosis with final rupture of an abscess near the insertion of the tendo Achillis takes place.

The astragalotarsal joints may become affected secondarily by extension of the tuberculous process from the neighboring bones and joints. It sometimes happens, however, that the tuberculous foci break through on the lateral or dorsal surfaces of the foot, the neighboring joints escaping.

Treatment.—The treatment of acute and chronic inflammation of the astragalotarsal joints, as well as that of the remaining tarsal joints, is to be carried out on the general principles governing joint disease elsewhere. Free exit must be given to pus, and all carious bone removed with the gouge, chisel, or sharp spoon. If a bone is extensively infected in this region with tuberculous disease it should be removed *in toto.* This includes both the astragalus and the os calcis. In some cases amputation by the method of Syme, or even a supramalleolar amputation, may be necessary.

Inflammation of the Bones and Joints of the Metatarsus.—Acute osteomyelitis may occur in the metatarsal bones, followed by caries, or partial or complete necrosis. The sequestrum becomes detached, and may be easily removed.

Tuberculous inflammation is observed with comparative frequency, either alone or combined with disease of the tarsus and ankle. The disease may commence either in the joint, giving rise to a characteristic swelling, or in the metatarsal bone as a tuberculous osteoarthritis. Disease of a tarsometatarsal joint endangers the entire tarsus, extending to the scaphoid through the joints between the cuneiform bones, thence to the astragalotarsal joints, and finally reaching the ankle-joint. Pus may form beneath the plantar aponeurosis as the result of caries of the metatarsal bones.

The best conservatism here is a **prompt and thorough operative treatment,** in order to arrest the disease before it extends to the tarsus. Single diseased bones are to be removed, diseased soft parts are to be scraped away, the involved phalanx of a toe removed, etc. Finally, amputation of the foot by Chopart's, Lisfranc's, or Syme's method may be necessary.

Metatarsalgia (**Morton's painful foot**) is a name given to a painful affection of the foot, which arises mainly from wearing narrow shoes. It sometimes depends on gout. The pain is generally localized in the head of the fourth metatarsal bone, and is sometimes caused by pressure against the adjacent nerve; the head of the bone may be dislocated. If not relieved by wearing a broad shoe, the head and a portion of the shaft of the bone should be resected. Cases depending on gout should be treated accordingly.

Gout or **arthritis uratica** is a local manifestation of a general nutritive disturbance (the gouty diathesis), occurring most frequently in the metatarsophalangeal joint of the great toe. Deposits occur in and about the joint, consisting of various combinations of uric acid. In the acute form there is pronounced phlegmonous inflammation in and about the joint, with severe pain which gradually increases for a few days and then subsides. The deposits can sometimes be felt in and about the joint and in the sheaths of the tendons. Abscesses may form which discharge a creamy material, sometimes containing uric acid salts. Local treatment is directed mainly to the alleviation of the pain, and consists in elevating the foot and wrapping it in flannel saturated with equal parts of belladonna, aconite, and chloroform liniments. Suppurative conditions are to be treated by incision, curetment, and antiseptic dressings. Chronic painful conditions due to arthritic deposits in the metatarsophalangeal joint of the great toe, occurring in otherwise healthy individuals, may be relieved by resection of this articulation. For the medical treatment of the uric acid diathesis the reader is referred to works on general medicine.

CONTRACTURES OF THE ANKLE-JOINT

Contractures of the ankle-joint are very rare. They occur from burns and also from deep inflammatory conditions of the calf muscles involving the muscular structures. The most frequent and important contracture of this joint is **talipes equinus,** in which the foot is in plantar flexion, the heel being drawn upward and the toes directed toward the ground (Fig. 853). It is most frequently caused by paralysis of the muscles of the leg, the foot falling by its own weight into plantar flexion. The muscles of the calf become permanently shortened and the extensor muscles in front become stretched.

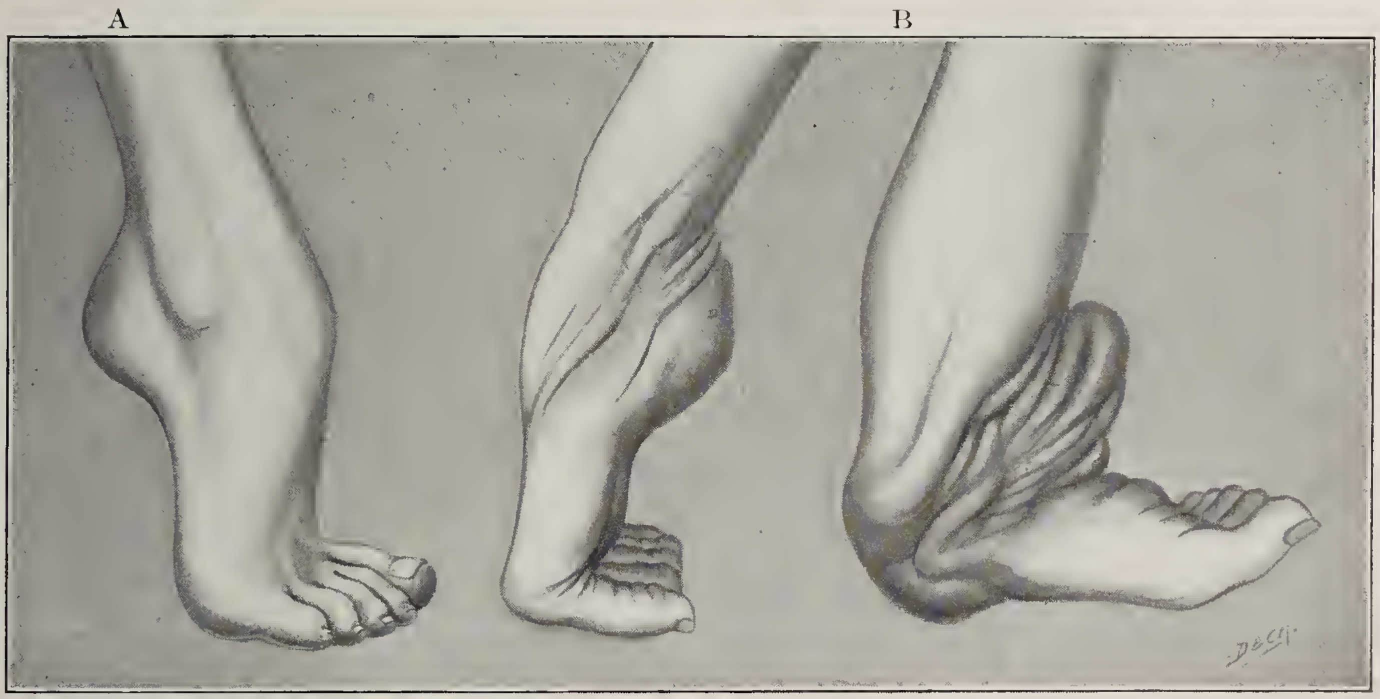

Fig. 853.—Different Degrees of Paralytic Talipes Equinus.
A, The average case; B, extreme forms.

There is increased tendency to pointing of the toes and elevation of the heel and the range of passive motion at the ankle-joint becomes more and more restricted. In patients who can walk the development of talipes equinus is in a great measure prevented by the fact that the weight of the body forces the foot to a right angle with the leg, so that the tendency to shortening of the calf muscles is antagonized. Talipes equinus does not depend, as was formerly supposed, on the antagonistic action of the calf muscles, with paralysis of the extensors alone. It occurs most often in infantile and other forms of paralysis; it may develop in patients who are greatly weakened and confined for a long time in bed. It also occurs in ankle-joint disease and as a result of injuries to the nerve-trunks. **Pes cavus** or hollow foot may also be present in talipes equinus as a result of the pressing together of the ends of the arch of the foot from the action of the weight of the latter. **Hyperextension of the toes** occurs in the later stages, from shortening of the extensor of the toes; the plantar fascia and the plantar muscles may be shortened secondarily. The tarsal bones are altered in shape from abnormal points of pressure, and their normal relations, particularly those of the astragalus to the tibia in the formation of the ankle-joint, are disturbed. The prominence caused by the subluxation forward of the latter is sometimes pronounced. In still more advanced cases the patient may walk on the dorsal surface of the toes, or even on the dorsum of the foot (Fig. 853, B).

The **treatment** consists, first, in the prevention of the deformity by proper attention to the position of the foot in cases of paralysis of the leg muscles, and in those who are confined in bed for a long time. In developed cases the treatment of the cause, as well as of the deformity itself, must be considered. In cases of injury involving division of a nerve-trunk, suture of the nerve, followed by electricity and massage, is indicated. In cases of cicatricial contractures of the muscles of the calf resulting from deep inflammatory conditions the tendo Achillis must be divided, the foot brought into a normal position, and in the after-treatment, active and passive movements, and massage applied. In paralytic affections, whether of cerebral, spinal, or peripheral origin, the function of the muscles must be preserved by the use of electricity and massage. Where the deformity is due to cicatricial contracture of the skin, the cicatrix is to be divided and the defect resulting from the correction of the malposition filled with a flap with a pedicle obtained from the vicinity, or from the other leg.

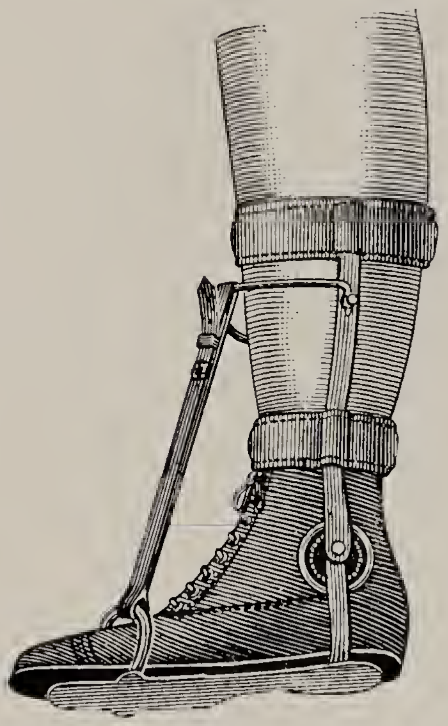

Fig. 854.—Sayre's Apparatus for Correction of Talipes Equinus.

In the average case of developed talipes equinus forcible correction under an anesthetic should be attempted, and, if successful, the foot is to be maintained in position at first by means of a plaster-of-Paris splint; afterward an apparatus consisting of a leg girdle connected to a laced boot by two lateral splints and lever springs attached to both sides of the boot to maintain the foot at a right angle, should be worn (Fig. 854). The patient should be encouraged to walk about. In still later stages the correction will have to be assisted by the operation of **évidement** of the interior of such of the tarsal bones as offer obstruction to reduction, particularly the astragalus (Ogston). A small opening in the exterior hard covering gives access to the cancellated structure, and through this, with a Volkmann's sharp spoon the interior is carefully broken up and worked out until nothing but a shell is left. The bones are now easily molded into proper relations with one another and the normal contour of the foot restored. The tendo Achillis acts as a fulcrum in effecting the restoration, and should not be divided until the latter is secured. If the shortened arch persists, and the exaggerated dorsal flexion of the toes does not yield to orthopedic mechanic treatment, they may be dealt with operatively at a later period; the shortened arch is to be corrected by subcutaneous rupture or section of the plantar fascia, or in extreme cases, by deep open section (Phelps), and the dorsal flexion by tendoplasty (see page 358, Vol. I).

In **tenotomy of the tendo Achillis** the tenotome is introduced on one side of the tendon, passed in front of the latter, and, while an assistant forces the foot into a position of dorsal flexion the operator makes pressure on the tendon with the thumb of his left hand, forcing it against the tenotome, which is moved back and forth. The tendon is felt to give way, and the correction may be completed before the latter is entirely divided, some of the fibers rupturing, while others are simply stretched. Care should be taken not to divide the skin. As soon as the wound has healed orthopedic treatment and electricity and massage must be begun. Contracture of the plantar fascia is best treated by forcibly straightening the arch of the foot under an anesthetic. In extreme cases it may be necessary to divide it with the tenotome, or to perform open section (*vide supra*). The correction obtained is maintained by a splint, which is removed daily for the employment of passive movements and massage.

A "flail-joint," *i. e.*, one that is unable to support the patient in walking, is best treated by bringing about **ankylosis of the ankle-joint (arthrodesis)**. The joint is opened as for resection, the cartilaginous surfaces chiseled away, and the freshened surfaces secured in firm apposition. A plaster-of-Paris splint is applied.

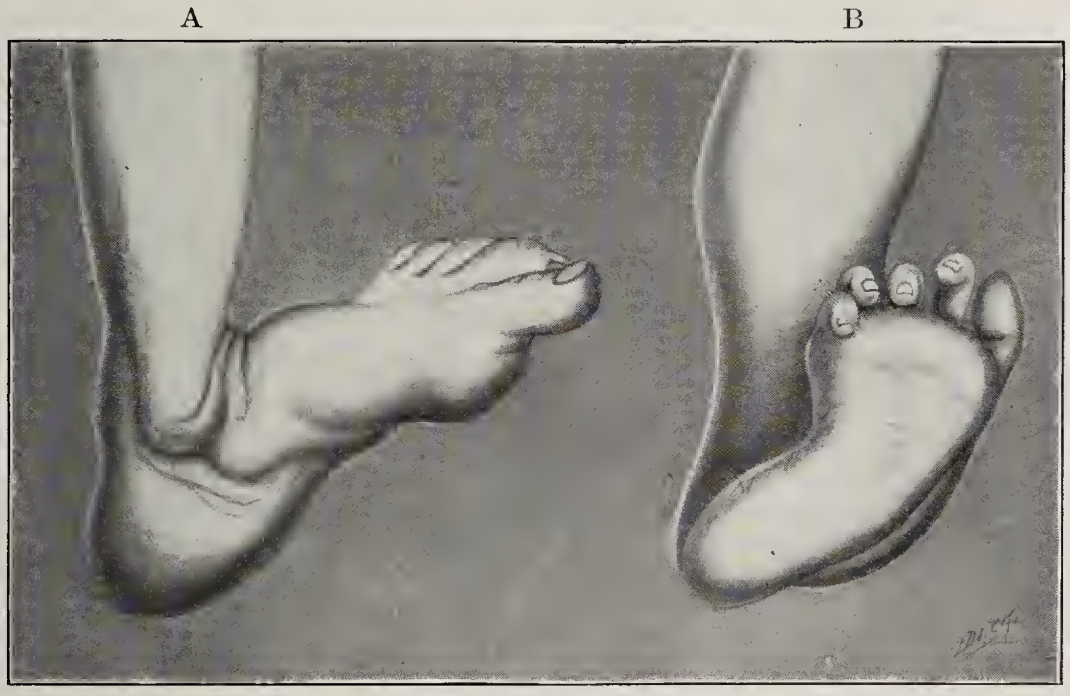

FIG. 855.—A, PARALYTIC TALIPES CALCANEUS; B, CONGENITAL TALIPES CALCANEOVALGUS.

Inflammatory contractures of the ankle-joint occur almost exclusively in the position of talipes equinus, and are, as a rule, the result of synovitis. In this, as in other joints, inflammatory conditions often end in fibrous or bony ankylosis. The treatment is directed mainly with reference to the latter.

Talipes calcaneus is the reverse of talipes equinus. The ankle is in dorsal flexion and the patient walks on the heel. It may be either acquired or congenital. When acquired, it is the result of paralysis (Fig. 855, A). The congenital form is usually associated with talipes valgus; the deformity is then called talipes calcaneovalgus (Fig. 855, B). These deformities result most commonly from the **"essential" spinal paralysis of infancy (acute anterior poliomyelitis)**, usually occurring between the second and the sixth year; they may arise from injuries. In the congenital form they are due to abnormal pressure in the uterus. A slight dorsal flexion is present at birth, and in their first efforts to walk children tread on the heel.

Certain **anatomic changes** occur in the os calcis and the astragalus. The former is abnormally developed in its anterior part, and the latter is flattened and lengthened. Corresponding changes occur in the articular surfaces.

Treatment.—The treatment of congenital talipes calcaneus consists in the frequent employment of corrective movements by manipulation, and fixation of the foot by means of an anterior leg splint which embraces likewise the dorsum of the foot. The treatment should commence at birth and overcorrection should be made at least once daily. In paralytic cases the treatment is similar to that of talipes equinus. A brace with an elastic cord to supply the action of the gastrocnemius muscle (Fig. 856) should be worn (Volkmann). The indications for arthrodesis are the same as in talipes equinus.

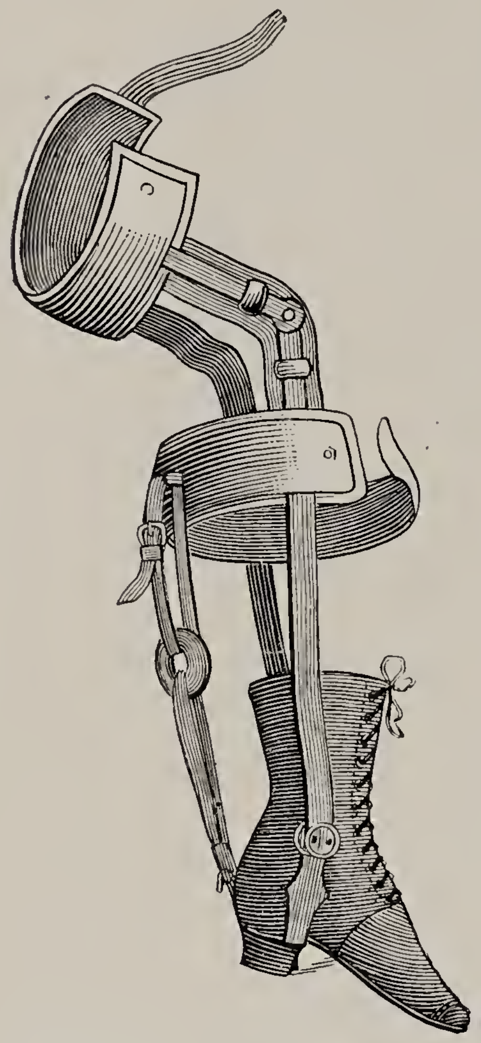

Fig. 856.—Volkmann's Apparatus for Talipes Calcaneus.

Contractures at the Astragalotarsal Joints.—The most important of these contractures is **talipes varus** or clubfoot. It may be congenital or acquired. According to Dieffenbach, **congenital talipes varus** is present in one out of every thousand children born. It is double in more than half the cases that occur; in one-sided cases it is found to occur more frequently on the left side.

Congenital talipes varus is usually associated with more or less talipes equinus, constituting a **talipes equinovarus.** In very rare cases it is paralytic in origin. It is a supination-adduction contracture at the astragalotarsal joint, depending on contracture of the muscles and the corresponding shortening of the ligaments and fascia, and associated with disturbances of development of the bones and joints of the tarsus, particularly the astragalus and the astragalotarsal articulations. It is an exaggeration of the slight degree of physiologic congenital talipes present at birth, which disappears as the result of standing and walking. In pathologic clubfoot the deformity increases as a result of abnormal growth of the bones, the latter, in its turn, depending on forced supination due to either an abnormal position of the fetus *in utero* or a disproportion between the size of the fetus and that of the uterine cavity. Traces of pressure of the uterine walls have been observed in the shape of circumscribed atrophic areas of the skin and bone. Volkmann, Lücke, and Lossen each observed a case in which the action of pressure was illustrated by the occurrence of congenital talipes varus on one foot and talipes valgus on the other, the feet fitting exactly into each other.

The **anatomic changes** consist of alterations in the form of the tarsal bones and the position of the joints. The bones grow in the direction in which pressure is relieved, while growth is diminished where abnormal pressure is exerted. The changes in the bone are particularly noticeable in the os calcis and the astragalus. The anterior process of the former, which normally limits pronation, is greatly increased in height, while the sustentaculum tali, which limits supination, is absent. The result of these changes is to limit pronation, and to favor supination. The neck of the astragalus is lengthened and bent downward and inward, the body is flattened and wedge-shaped and displaced to a position of plantar flexion and adduction. The astragalotarsal joints and the articulations of the cuneiform bones are displaced to correspond with the supination-adduction. Supernumerary joints may develop between the internal malleolus and the scaphoid, and between the outer surface of the os calcis and the posterior border of the external malleolus (Hueter). The only abnormality of the muscular structures is the displacement of the tendon of the peroneus longus, which, instead of passing through a groove in the cuboid on its way to the plantar surface, passes through a groove in the os calcis. The latter is supplied with the same cartilaginous cover to form the wall of the normal sheath as when the tendon takes a normal course. The involved muscles are shortened, however, corresponding to the supination contracture. There is an associated outward rotation of the thigh and inward rotation of the leg.

These anatomic conditions remain practically unchanged until the patient commences to walk, when every feature becomes exaggerated under the pressure exerted by the weight of the body; the patient walks at first on the outer side of the foot, and finally on the dorsum, on which callosities form, and subcutaneous bursae develop. The deformity of the bones and joints increases and the muscular structures become atrophied. The nutrition of the foot is impaired, it remains small and stunted, and the skin is bluish and cold.

Treatment.—The treatment of congenital clubfoot should commence immediately after birth. With the growth of the bones the deformity becomes more and more intractable. In the milder cases simple manipulation, aided by bandaging to maintain the correction and change the points of pressure on the bones in order to improve the shape of the latter, is sometimes sufficient. One method is to force the foot into position and hold it there while the initial end of a piece of adhesive plaster is placed at the base of the little toe on the dorsum, carried across the latter beneath the sole and finally along the outer side of the leg. This holds the foot in position while a plaster-of-Paris dressing is applied (Ogston). As the varus improves the equinus is to be corrected by tenotomy of the tendo Achillis. In the severer cases the tendons of the tibialis posticus, flexor longus digitorum, tibialis anticus, and even the internal lateral ligament, may require division. Operations on the bones of the foot in young children are rarely necessary. After cure of the club-foot, however, **linear osteotomy** of the leg, or **supramalleolar osteoclasis** (Vincent), is sometimes required to overcome the inward rotation of the foot (adduction), which persists in spite of every effort to correct it with orthopedic apparatus.

Forcible correction (subcutaneous rupture of the soft parts by brisement forcé), by pressing together the bones at the convexity at the outer side of the foot, and rupturing the ligaments or their insertions at the concavity on the inner side, may be employed in obstinate cases. **Phelps's operation of immediate correction by open incision** consists of putting the soft parts on the stretch and dividing skin, fascia, and tendons to the bone. The wound is left open and dressed antiseptically, and the correction is maintained by a plaster-of-Paris splint applied over the dressings. This operation is to be employed only in cases of considerable severity and in neglected cases occurring in young patients. In long-standing cases in adults various operations on the bones of the tarsus, such as cuneiform osteotomy on the dorsum and outer side of the foot, excision of the astragalus, évidement (see page 614), excision of the cuboid, resection of the neck of the astragalus, etc., may be required, according to the existing conditions. In all these operations slight overcorrection is to be secured and maintained by plaster-of-Paris bandages applied over the wound dressings. Finally, in some cases the conditions present defy all efforts at correction, and the patient must either submit to the necessity of walking for the rest of his life on the misshapen foot, or accept the alternative of **amputation.**

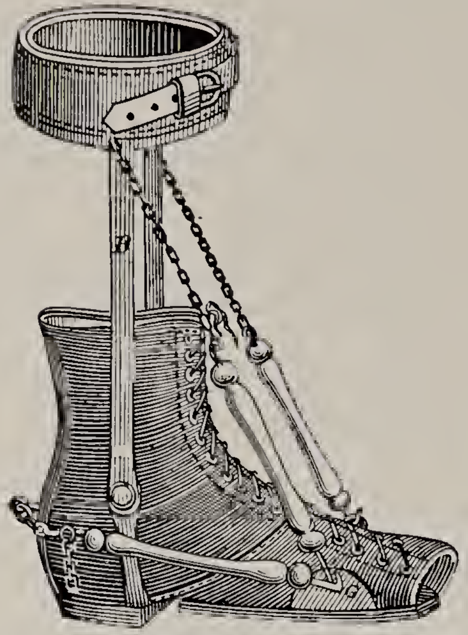

Fig. 857.—Sayre's Shoe for Clubfoot.

In the treatment of clubfoot cases it should always be borne in mind that orthopedic apparatus can never produce correction of the deformity. Correction must be secured by other means and this must be done thoroughly and efficiently. If orthopedic apparatus maintains the correction after it is secured, this is all that can be expected of it. With this in view, Sayre's clubfoot shoe may be worn (Fig. 857).

Talipes valgus or **flat-foot** (Fig. 858) is a pronation contracture, which, though sometimes congenital, in its fully developed form is generally acquired. A slight degree of flat-foot is not uncommon among infants (8.6 per cent, Küstner). Well-marked cases of congenital flat-foot may be associated with other evidences of rudimentary development, such as absence of the fibula and of the toes (Wagstaffe), osseous union of the os calcis and scaphoid (synostosis), and anomalies of the central nervous system, namely, in congenital paralysis. If flat-foot develops on the basis of the absence of the normal arch of infancy it is due to rachitic causes (**rachitic talipes plano-valgus.**)

Acquired flat-foot occurs at the age of puberty in weakly individuals who are compelled, from the nature of their occupation, to support the weight of the body for a long time. In all probability many of these cases have a rachitic foundation, an abnormal softness of the bones being present. The lower epiphysis of the tibia is bent, so to speak, somewhat after the manner of genu valgum, and the shaft rests obliquely on the epiphysis (Tillmanns). In conse-

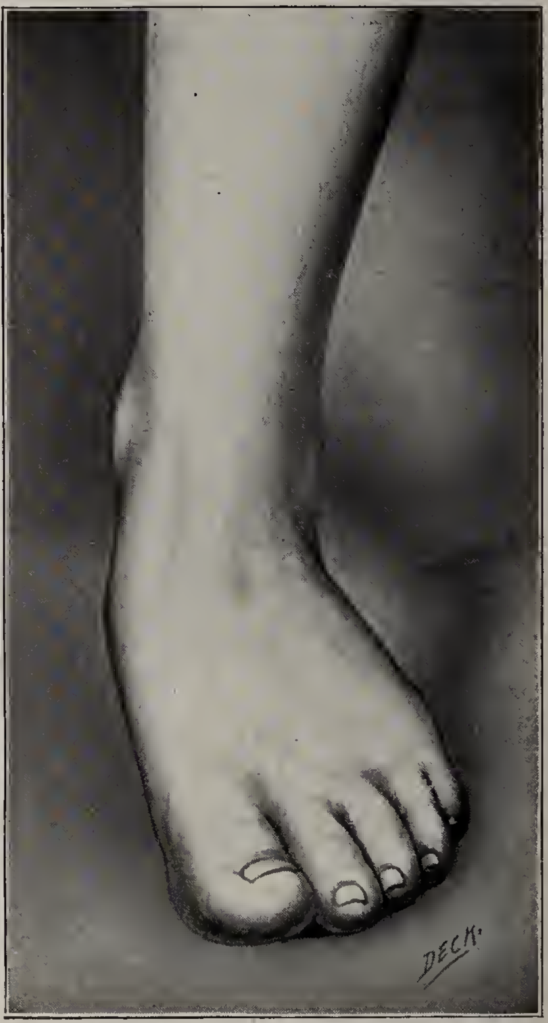

Fig. 858.—Flat-foot.

quence of this and the superimposed weight of the body the arch of the foot tilts over to one side, and the sole, as a result, is flattened.

In the **anatomic changes** which ensue the opposite of those which are present in talipes varus occurs. The anterior process of the os calcis, which inhibits pronation, is restrained in its growth, while the sustentaculum tali, which restrains supination, is abnormally developed. The astragalus no longer supports the arch as its keystone; its shape is reversed, and, instead of being widest in an anteroposterior direction at its upper surface it is narrow at this point, and widest at its lower surface. It is tilted forward as a whole, its anterior articular surface is depressed, and the ankle-joint is in plantar flexion, as a consequence. Erosion of the bony surfaces may be present, in consequence of the pressure.

In addition to this, the muscles and ligaments take part in the development of the deformity. The tibialis posticus and the short plantar muscles, which support the arch of the foot, together with the plantar fascia, finally yield. There are coincident circulatory disturbances, varicose veins, etc., in some cases.

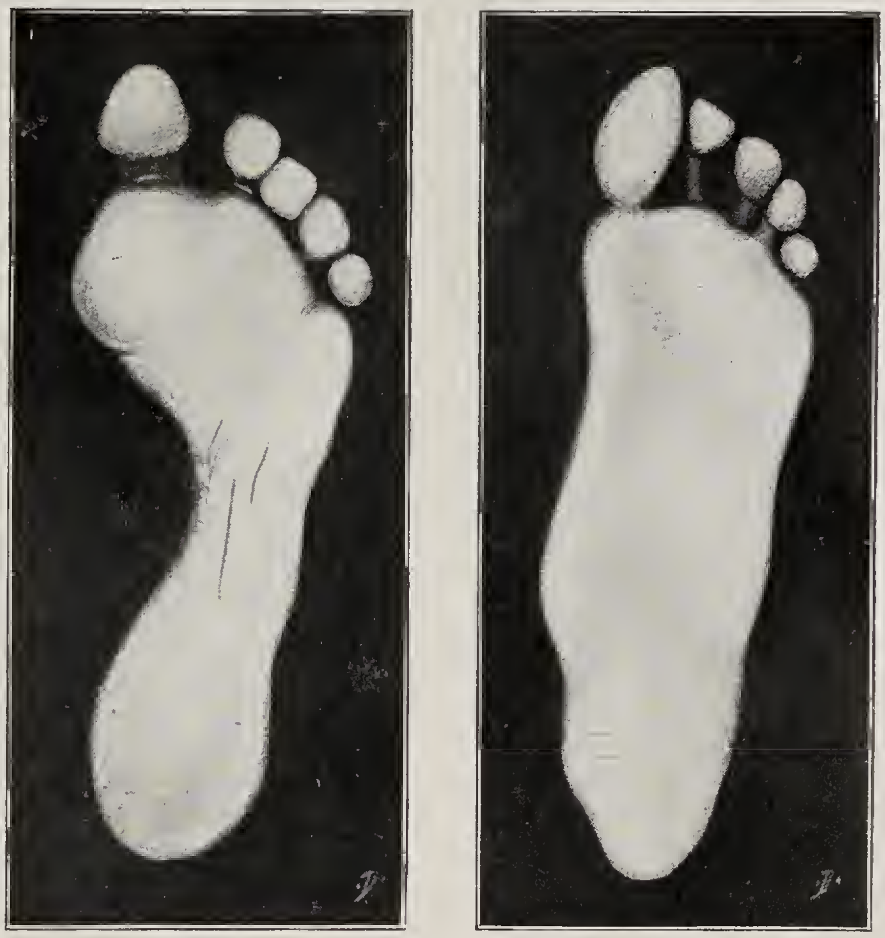
A B

Fig. 859.—A, Impression of Normal Foot; B, Impression of Flat-foot.

The **symptoms of flat-foot** are pain and slight fatigue, though these are not always present in childhood and in the commencement of the deformity in adults. Again, in cases that have existed for a long time in adults the discomfort may be very slight or absent altogether, the patient exhibiting only an awkward gait, and perhaps tiring easily on long standing or walking. In other cases the pain in the tarsus may be severe, almost preventing him from walking or standing. This variety may come on more or less suddenly, and has been called "**inflammatory flat-foot.**" This is liable to be mistaken for rheumatism. There is a characteristic location of pain (1) behind the tuberosity of the scaphoid corresponding to the calcaneoscaphoid ligament; (2) about the middle of the dorsum of the foot external to the head of the astragalus; (3) over the anterior process of the os calcis in front of the external malleolus. A true inflammation is not present, however. After these attacks the foot becomes fixed in its position of pronation, the patient walks with the feet spread apart in order to give the latter the fullest possible pronation, and the elasticity of the gait is lost. Supination causes extreme pain, and the attempt to produce this passively elicits a sort of soft crepitus, suggesting the rupture of adhesions.

Treatment of Flat-foot.—During the period of development of flat-foot in children the essential point in the treatment is to compel the patient to walk on the outer side of the foot, supination being thus encouraged. To effect this he should wear a laced high shoe, with a high and broad heel which extends well forward to the site of the articulation between the os calcis and the cuboid. The inner side of this heel, and the sole as well, should be increased at least a half inch in thickness. At the same time a thin steel flap or inside sole, curved to fit the normal arch (Whitman) and covered with gutta-percha, is to be worn inside the shoe to support the arch (Fig. 860). In the cases in which these measures fail to compel the patient to walk on the outer side of the foot, the application of an internal splint, jointed at the ankle and extending to an encircling band at the knee, will assist in supinating the foot. Massage of the foot and of the muscles of the leg should not be neglected. During an acute exacerbation in inflammatory flat-foot the patient should assume the recumbent position, when supination sometimes occurs from the weight of the foot. After a rest in bed of from seven to fourteen days he may be permitted to walk with a Whitman's curved steel plate in the shoe to support the arch.

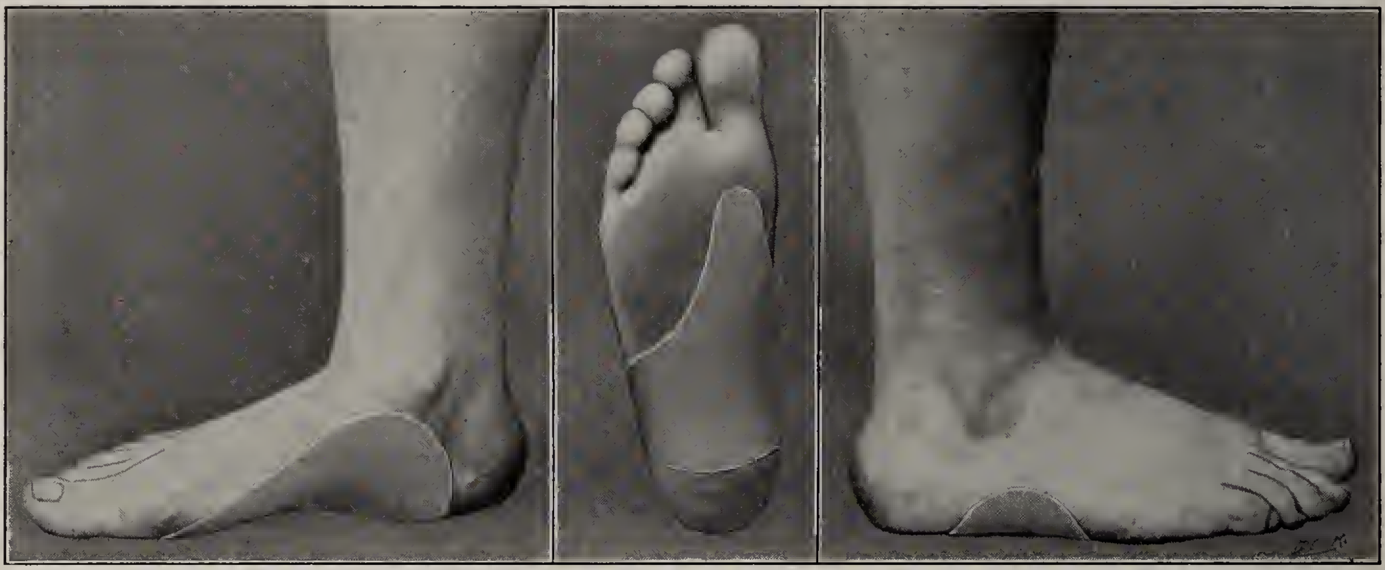

FIG. 860.—WHITMAN'S PLATE TO SUPPORT THE ARCH OF THE FOOT IN FLAT-FOOT.

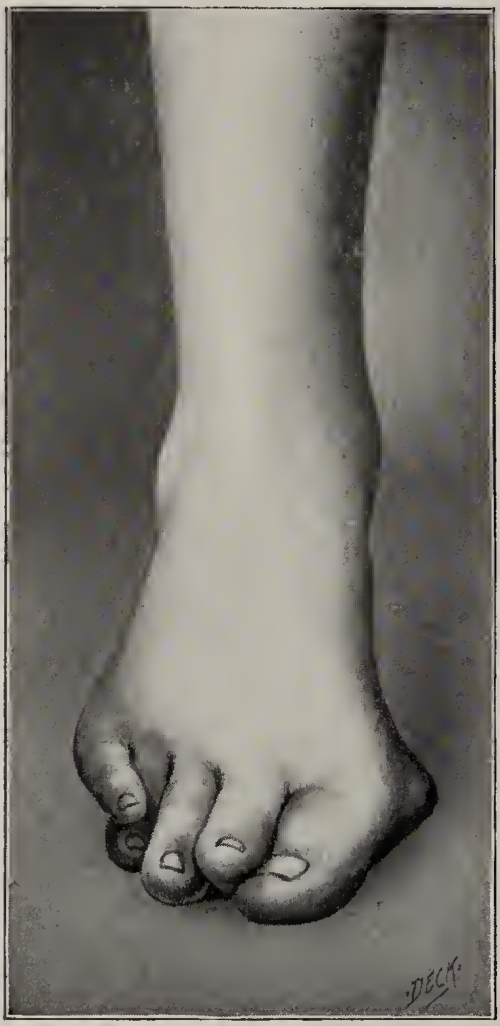

FIG. 861.—HALLUX VALGUS.

Forcible supination of the foot is of the greatest possible benefit in **spastic** or inflammatory flat-foot. This may be accomplished under a general anesthetic, or cocain may be injected at the previously demonstrated painful points. The manipulation should be persisted in until oversupination is effected. The foot should then be put in plaster-of-Paris and the procedure repeated after a few days (Whitman).

Operative measures for the correction of the deformity consist of (1)

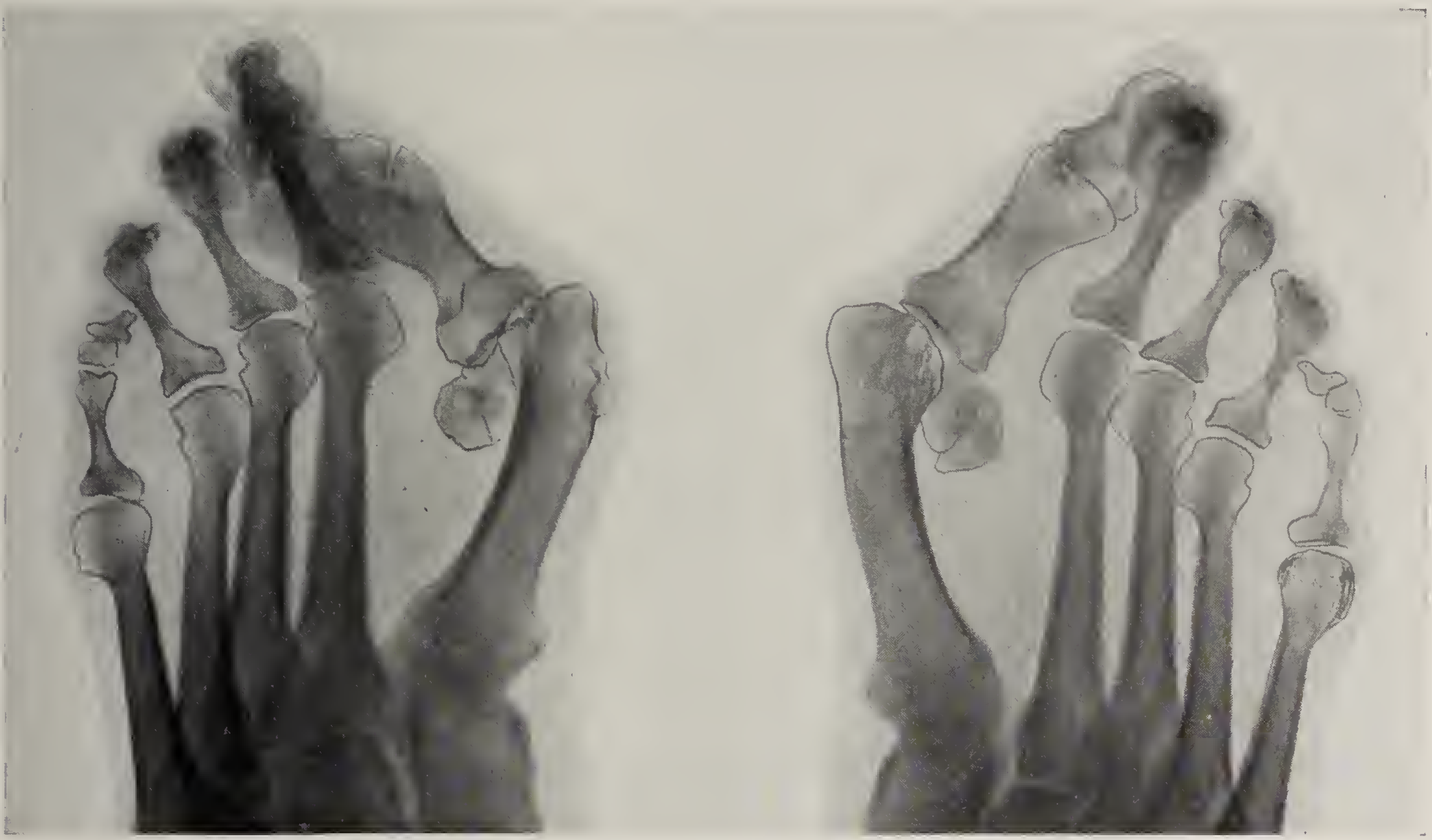

Fig. 862.—Skiagram of a Case of Hallux Valgus.

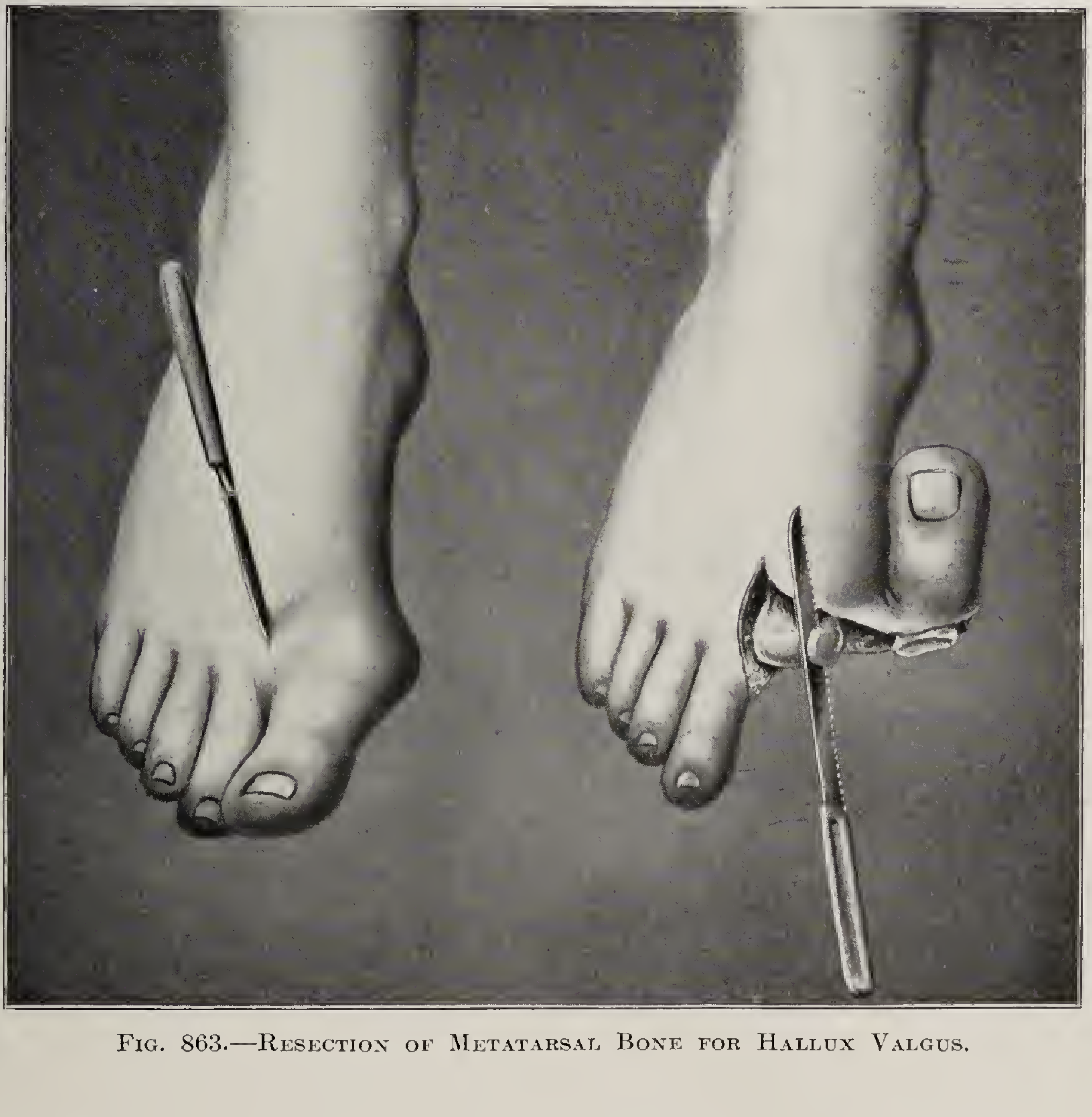

Fig. 863.—Resection of Metatarsal Bone for Hallux Valgus.

Ogston's operation for the formation of a synostosis between the astragalus and the scaphoid by resection of the astragaloscaphoid joint; (2) extirpation of the astragalus; (3) extirpation of the scaphoid (see Resection of the Tarsal Bones for Talipes); (4) Trendelenburg's supramalleolar linear osteotomy. This is a rational procedure in cases of rachitic bending of the lower portion of the shaft of the tibia. The correction produces a condition of bowleg. The same result may be procured by osteoclasis.

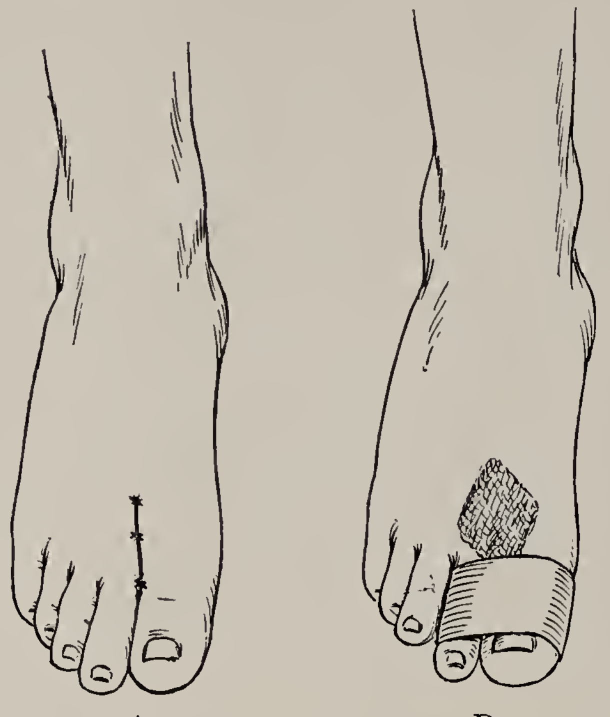

Fig. 864.—Resection of Metatarsal Bone for Hallux Valgus.
A, Sutures applied; B, dressings applied.

Hallux valgus is an abduction contracture of the great toe, with more or less displacement of the corresponding metatarsal bone. In severe cases the great toe lies under the others (Figs. 861 and 862), and the two outer toes may lie on top of or under the middle toe. The flexor and extensor tendons become gradually shortened and displaced. Arthritis deformans gradually develops and a bursa forms over the prominent head of the metatarsal bone which frequently becomes inflamed, forming a **bunion.** The treatment consists of removal of the exostosis which develops on the head of the metatarsal bone, and, if necessary, resection of the base of the first phalanx. In order to remove the resulting cicatrix from subsequent points of shoe pressure the incision may be made between the great toe and the adjoining toe, as in Petersen's resection for tuberculous disease. The great toe is dislocated outward and finally reversed (Fig. 863), after which the exostosis is removed, and, in addition, if the tension on restoration is great, the base of the first metatarsal bone is resected. Finally, the tendon of the extensor proprius hallucis is divided and reattached on the median side of the phalanx.

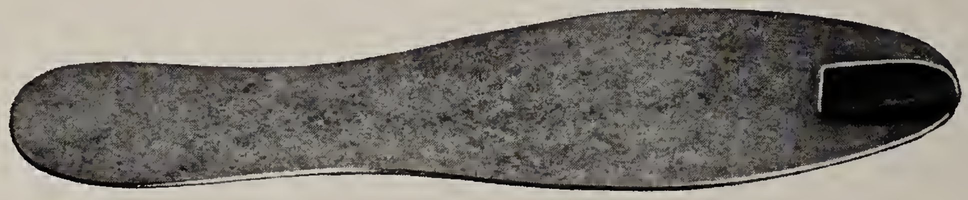

Fig. 865.—Inside Sole for Use in Hallux Valgus.

To prevent recurrence the patient wears a divided stocking and an inside sole made of leather with a vertical splint, or partition, to maintain the corrected position of the toe (Fig. 865).

Congenital absence of the toes is sometimes observed, as well as deformities of congenital origin similar to those which occur on the hand.

TUMORS OF THE LEG AND FOOT

Certain tumors of the skin of the foot that are the result of proliferations of the epidermis are known as **callosities** and **corns.** There is a diffuse epidermal proliferation in the case of the former; the **clavus,** or **corn,** is a circumscribed tumor characterized by the production of circumscribed horny epidermal masses. It is found most frequently on the external side of the small toe; it may be situated wherever the pressure of the shoe is exerted on a prominent portion of the foot. There is an accumulation of normal nutritive matter in the rete Malpighii beneath the horny layer, pressure on which by the latter affects the nerve filaments and produces pain. "Cutting the corn" consists of shaving away the thick horny layer, but this exposes the rete Malpighii, in which infection may take place and inflammation ensue. This may become phlegmonous, or even lymphangitis or erysipelas may follow. In old persons **senile gangrene** may have its origin in this manner. The proper treatment consists in softening the horny masses with an alkali (a 2 or 3 per cent solution of carbonate of soda) and lifting the clavus from the underlying tissues. **Inflamed corns** should be protected from pressure by superimposed layers of adhesive plaster with a perforation in the center. A good plan of treatment is to paint the corn every night with a mixture composed of 1½ drams of salicylic acid, 10 grains of extract of cannabis indica, and 1 dram of collodion. After a few applications the corn is softened by the alkaline solution above mentioned, and removed. Soft corns are best treated by washing with tincture of green soap, removing the softened epithelium, dusting with equal parts of boric acid and oxid of zinc, and packing absorbent cotton between the toes. **Radical treatment** in intractable cases of soft corns consists in dissecting away the skin from the adjacent surfaces of the toes, and suturing these together, so that the interdigital cleft is obliterated and the two toes converted into one.

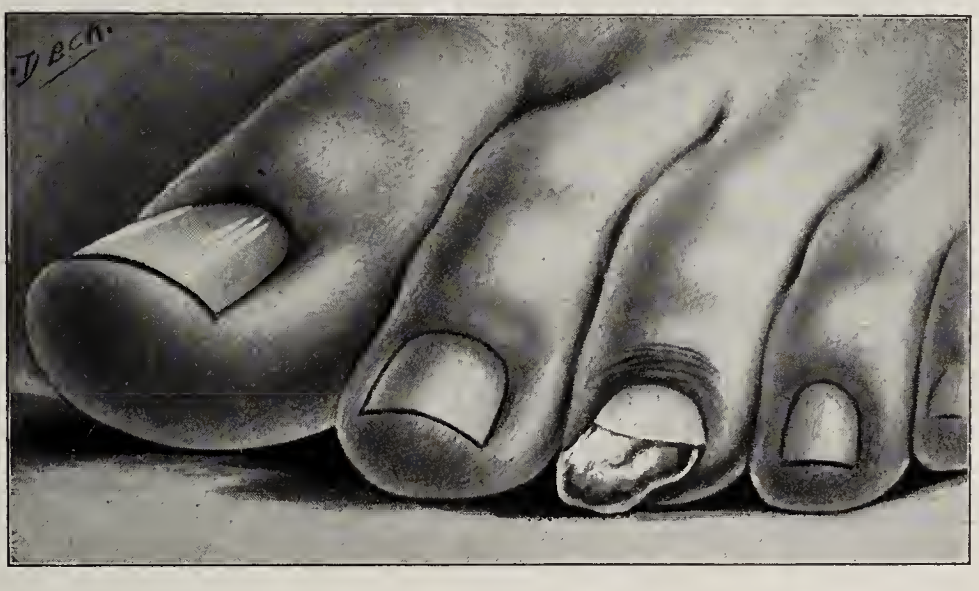

FIG. 866.—OSTEOFIBROMA SPRINGING FROM THE MATRIX.

Warts are very uncommon on the feet.

Fibromas sometimes occur in the subcutaneous connective tissue of the dorsum of the foot, and on the leg. These, though small, may yet become troublesome by the involvement of subcutaneous nerve branches, the resulting pains demanding extirpation. Larger fibromas are found springing from the plantar surface and forcing their way between the metatarsal bones to the dorsum. **Lipomas** occasionally develop from the adipose tissue of the dorsum, and by their soft consistency and flabby structure simulate hygromas of the sheaths of the tendons. Osteofibromas sometimes spring from the matrix of the toe-nails (Fig. 866).

Subcutaneous varices are found on the leg and the dorsum of the foot. They are a frequent source of annoyance, and sometimes lead to edema, intractable eczema, and ulceration. The branches of the internal saphenous are most frequently affected. **Ligation of the internal saphenous vein at the saphenous opening** (Trendelenburg) is indicated in cases in which, after the dilated veins of the extremity are emptied by placing the patient in the recumbent position and elevating the limb, these fail to refill when pressure is applied at the saphenous opening as the patient resumes the upright position. The vein is easily reached by an oblique incision made just below the level of the saphenous opening at the junction of the anterior surface of the thigh with the internal surface, and in a direction parallel to Poupart's ligament. Two ligatures are applied, and the vein between them divided. **Ligation of the external saphenous** in the midline of the popliteal space is sometimes required in addition. The method by **circular incision** (the garter operation of Schede) aims permanently to interrupt the return circulation of the entire superficial set of veins, and force the blood through the deeper channels on its return from the limb. The incision includes the skin and fasciae, and is similar to the skin-cut of a circular amputation. It is made just below the knee. The veins are tied and the wound sutured. All three of the above operations are sometimes advantageously combined in the same case. **Resection** of the larger veins, varying lengths of these being removed, either through long incisions, or by tunneling between short incisions, is useful, and is less liable to be followed by recurrence than **multiple ligation,** which is sometimes practised. **Intermuscular varices** are found more particularly in the belly of the gastrocnemius muscle. They sometimes precede the development of the subcutaneous varices and are recognized by the doughy swelling of the calf. Pains are produced by walking, and rupture sometimes takes place.

Syphilomas of the skin and **syphilitic ulcer** occur at the anterior surface of the leg. Their frequent development in this region is probably due to the more exposed situation of the parts, leading to frequent contusions. **Syphilitic condylomas** occur at the points of contact of the toes. They resemble similar condylomas of the genitals, and mucous patches on the lips.

Melanotic sarcomas in the skin of the foot, and secondary development of the same in the leg, and finally over the whole body are frequently observed. Their occurrence on the foot is second in frequency only to those of the choroid membrane. Their predisposition to occur primarily in this region is not understood. Even **immediate extirpation** does not always protect the patient against metastasis. If other nodules are present over the body, operative interference is contraindicated.

Epithelial carcinomas sometimes develop in old persons on the basis of chronic leg ulcers. Whitish plugs can be forced out between the granulations, which exhibit the characteristics of epithelioma. Fistulous openings and cicatrices at the site of old necrosis of the tibia may likewise develop epithelial carcinomas. With **early amputation** the prognosis is favorable except in cases in which secondary glandular involvement is present. The latter should not be overlooked at the time of operation. The skin incision for the amputation must be well beyond the carcinomatous tissues.

Ganglions of the foot arise more frequently from the joints than from the tendons, the reverse of what occurs at the carpus. In both cases they appear on the dorsum with the greater frequency. In the case of the foot they attain a larger size, and are very much less movable. They are specially frequent near the joint between the cuboid and the fourth and fifth metatarsal bones, and at the external side of the foot near the anterior process of the os calcis; they are occasionally observed at the astragaloscaphoid joint. These ganglions have a very limited communication with the joint, and seem to develop from small separated inversions of the synovial membrane. The treatment is aseptic extirpation.

Lipomas of the sheaths of the peroneal muscles and of the extensor communis digitorum may simulate hygromas of these sheaths. Operation may be the sole means of clearing up the diagnosis.

A bursa mucosa due to boot pressure may develop on the dorsum of the foot at a point corresponding to the posterior extremity of the first metatarsal bone or at the highest point of the instep. Periostitis may follow, and finally an osteal growth. The bursa is to be incised and any bony proliferation present removed.

Free bodies are fortunately rare in the tarsal joints. In the case of the ankle-joint these are difficult to locate and remove. Chiseling away the malleolus in these cases in order to gain access is preferable to resection of the ankle-joint.

Osteomas and **exostoses** are observed, particularly at the upper and the lower end of the tibia. **Exostosis of the great toe** (Dupuytren) develops typically on the dorsum of the ungual phalanx of the great toe, between the bone and the nail. It gives rise to severe pain as it forces the nail upward. Its appearance usually dates back to a bruise with resulting periostitis and bony proliferation. In its removal, a horseshoe-shaped incision is made in such a manner as to turn back the matrix and the nail as a flap. The small tumor is then cut away by bone-cutting forceps and the nail and matrix are replaced. In case ulceration of the matrix has occurred the phalanx should be amputated. A similar osteoma may develop beneath the tendon of the extensor proprius hallucis; this may be extirpated without injury to the neighboring joint. Exostoses, in most instances, develop from the epiphysial cartilages.

Chondromas as well as osteomas, together with their mixed forms, are by no means so frequently found in the leg and foot as in the hand and fingers, but more frequently than in other portions of the skeleton, except on the ribs. Amputation for these growths may be performed with less hesitation than in the case of the fingers.

Syphilomas appear at the tibia as gummatous periostitis and gummatous thickening of the cortical lamella, the inner surface of the tibia appearing rough beneath the skin. Syphilitic osteomyelitis may also occur.

Sarcomas of the bones of the leg are either of muscular or of periosteal origin. The tibia is more frequently attacked than the fibula. **Amputation above the knee,** rather than in the leg, is to be preferred. Sarcoma is rare at the foot. **Amputation of the leg** is the only resource.

Supernumerary toes, and also **supernumerary metatarsal bones,** and **webbed toes** occur. Supernumerary toes may be removed; webbed toes do not demand operative interference. **Giant growth** of single toes or of the entire foot, as well as congenital absence of toes, is rare.

AMPUTATION OF THE LEG

In former times low amputations of the leg were not employed for the reason that suppuration of the stump, necrosis of the tendons, and the defective artificial appliances of earlier days rendered these amputations dangerous and the functional results unsatisfactory. High amputations were preferred because of the more rapid healing on account of the absence of sloughing tendons, and for the purpose of getting rid of the long projecting stump present when the old-fashioned "peg leg" was used. Amputations were therefore performed at the "point of election," *i. e.*, at the junction of the upper with the middle third of the leg. At the present day amputation is performed at any portion of the leg (at the "site of necessity") from just below the knee-joint to the malleoli. The technic of the operation is practically the same in any portion of the shaft, and the present description will apply to the middle and lower thirds.

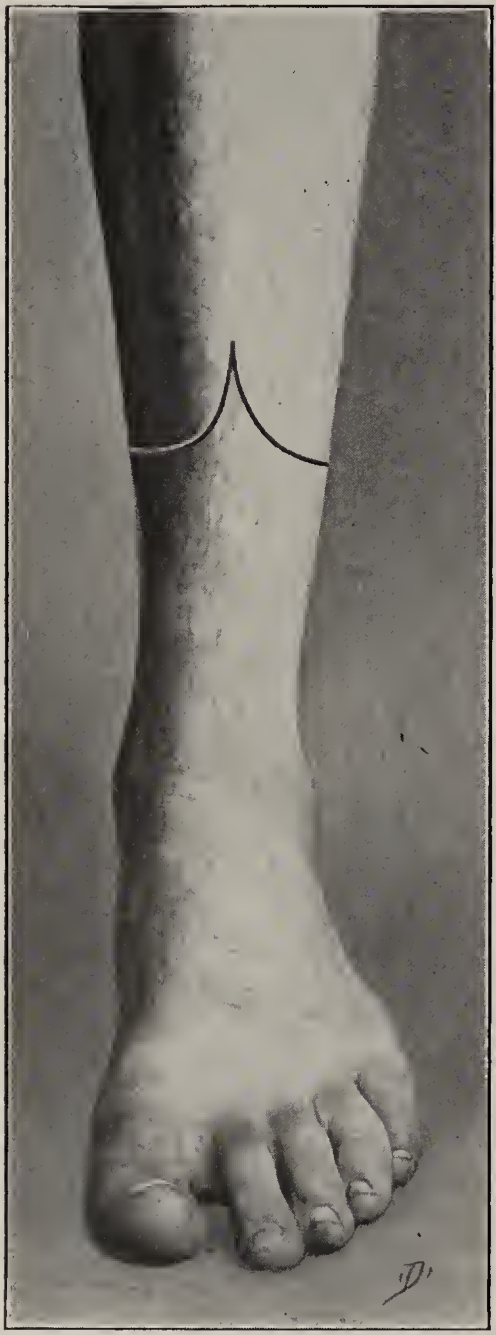

Fig. 867.—Amputation of Leg by Lateral Flaps.

Amputation of the Leg by the Method of Lateral Skin Flaps, with Circular Division of the Muscles.—This method possesses very decided advantages over the circular method sometimes practised, and may be employed in any portion of the leg. The base of the flaps corresponds with the level at which the bones are to be sawed. The margins of the flaps meet anteriorly in the line of the crest of the tibia (Fig. 867). The surgeon stands on the right side of the patient, places his left index-finger on the crest of the tibia, and his thumb at the same level behind in the middle line of the limb. Leaning over, he commences the incision close to his thumb and shapes the first flap on the side of the limb farthest from him. The flap is broadly oval, is three inches long, and ends at the index-finger. From here it commences again and sweeps in a similar manner on the side nearest the operator, terminating at the thumb behind. The incisions include the skin and fascia, which are dissected up, the muscles being divided by the long amputating knife in a circular manner slightly below the point of intended bone section. The tissues in the interosseous space are divided, the three-tailed retractor introduced, the muscular mass drawn well upward and the bones sawed across (Fig. 869). To prevent splintering the section of the fibula is to be completed first. It is not necessary to make a periosteal flap. The sharp anterior crest of the tibia is to be sawed off obliquely to prevent it from coming through to the anterior angle of the flaps.

In case of necessity the flap on one side may be longer than the other.

Teale's Amputation by Rectangular Flaps.— In this amputation the covering for the bone is ample, the position of the line of union of the flaps favors drainage, and the resulting scar is well out of the way of pressure. It is specially adapted to the lower third of the leg. The point where the bones are to be sawed is selected. The surgeon places his index-finger and thumb over the tibia and fibula and starts the incision at the point of the former, carries it in a straight line on the side of the leg which is the farther from him, for about four and a half inches in the average adult leg, then incises directly across the limb and up on the other side to the point located by his thumb. The long rectangular flap thus marked out, in both its length and its breadth must be equal to half the circumference of the limb at the point of division of the bone (Fig. 870, A). In dissecting up the anterior flap on the inner side, where the coverings are scanty, the knife is to be used carefully to prevent notching or "scoring" the raw surface of the flap, for this injures its vessels and endangers its nutrition; on the outer side the mass of extensors, anterior tibial vessels and nerves must be stripped up uninjured, blunt dissection replacing the knife edge as these are lifted from the interosseous membrane.

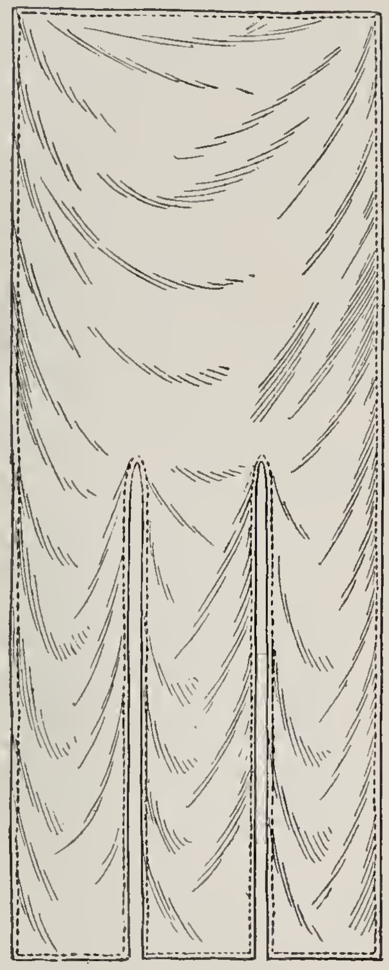
Fig. 868. — Three-tailed Retractor Used in Amputation of the Leg.

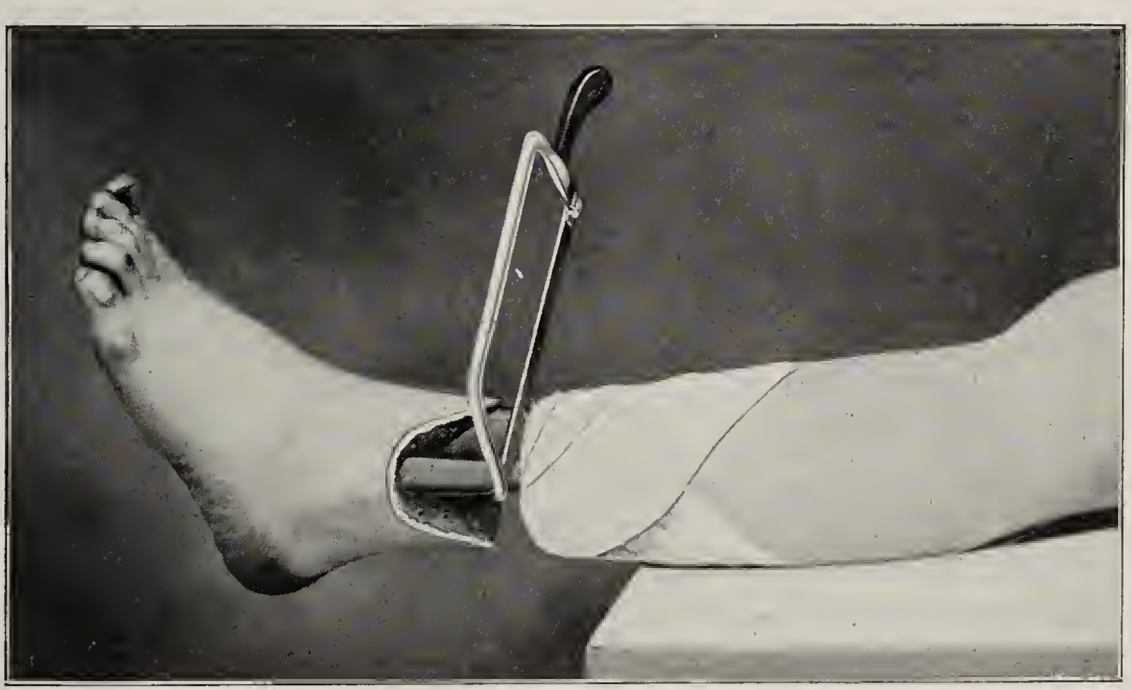
Fig. 869.—Three-tailed Retractor in Position.
The saw applied so as to complete the section of the fibula first.

The posterior flap is made by carrying a transverse incision directly down to the bone; this flap is made about one-third the length of the anterior flap. Both flaps are retracted, the interosseous membrane cleared, and the bones divided, the section of fibula being completed first. In approximating the flaps the anterior one must not be bent too sharply, lest its blood-supply be interfered with.

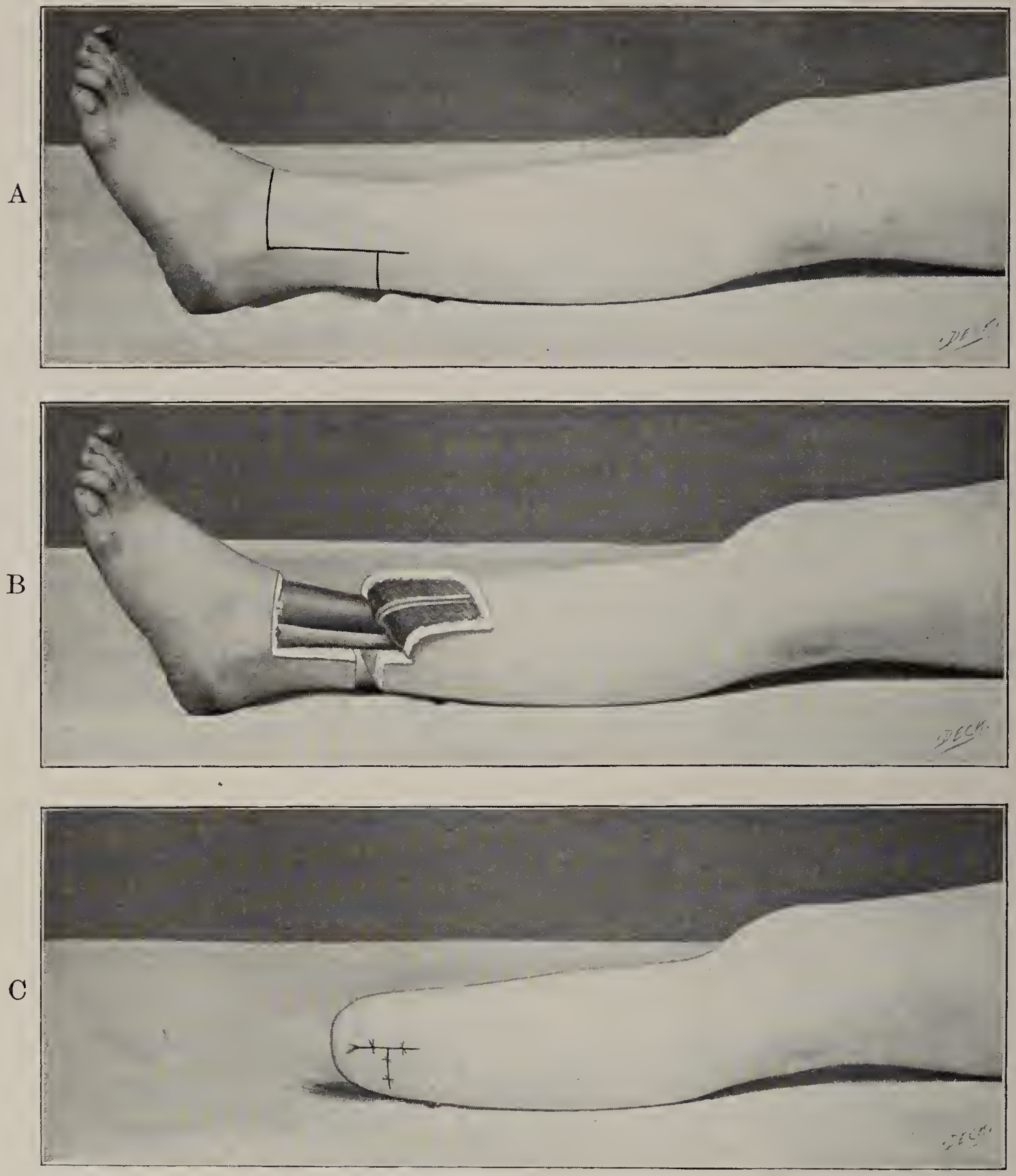

Fig. 870.—Teale's Amputation.
A, The lines of incision in Teale's amputation; B, the anterior flap turned back in Teale's amputation; C, the stump in Teale's amputation.

RESECTION OF THE ANKLE-JOINT

The following are the indications for this operation: (1) Suppurative inflammation of the ankle-joint due to incised and punctured wounds that cannot be controlled by incision and drainage. (2) Compound fractures of the malleoli, or compound dislocations, when followed by suppuration. (3) Gunshot fractures with excessive splintering, in which high temperature and grave constitutional disturbances show suppuration of the joint to have occurred.

(4) Tuberculous disease of the ankle-joint in advanced cases that do not yield to conservative treatment (injections of iodoform glycerin, and of carbolic acid). (5) Resection may be indicated in certain cases of free bodies in the joint which cannot otherwise be located.

Typic resection for disease of the ankle-joint is an operation of disputed value among some surgeons at the present day. It is claimed that the disease is often associated with disease of the tarsus, and even if the wound heals, the foot is of but little use. A previous resection destroys the advantages to be obtained by a Pirogoff's or a Syme's amputation, which not only gives a useful stump, but offers at the same time a better chance for radical cure (Jacobson). In children and in recent cases in young adults, however, the operation may be resorted to.

The best access to the parts is obtained by the operation developed by English surgeons, based on Langenbeck's method. The foot is laid on its inner side on a sand-bag. An incision 2½ inches long is made along the posterior border of the fibula to the tip of the malleolus, from which point it is carried at an angle to within an inch of the base of the fifth metatarsal bone (Fig. 871). The peronei muscles are isolated and drawn to one side, the bone is cleared, and the malleolus removed by dividing the bone with a narrow saw about two inches above the malleolus, and severing the external lateral ligament. A similar incision is made over the lower two inches of the tibia and carried forward and downward as far as the projection of the internal cuneiform bone. The dissection exposes the tendons of the tibialis anticus and the tibialis posticus, as well as the flexor longus digitorum and the flexor longus pollicis; these are carefully isolated and held aside. The posterior tibial vessels are avoided by keeping the knife close to the bone. On severing the internal lateral ligament the tibia and astragalus may be made to present at the wound by forcing the foot outward. The tibia is sawed off at the same level as the fibula, and a slice removed from the articular surface of the astragalus; or the entire bone may be removed, according to the nature of the case. The sawed surfaces and all soft parts are freed from any suspicious material, a few small branches of the peroneal and malleolar arteries ligated, and free drainage provided for by omitting sutures (Jacobson). Copious dressings are applied, and the foot supported by a Volkmann's posterior splint with foot-piece, and two side splints.

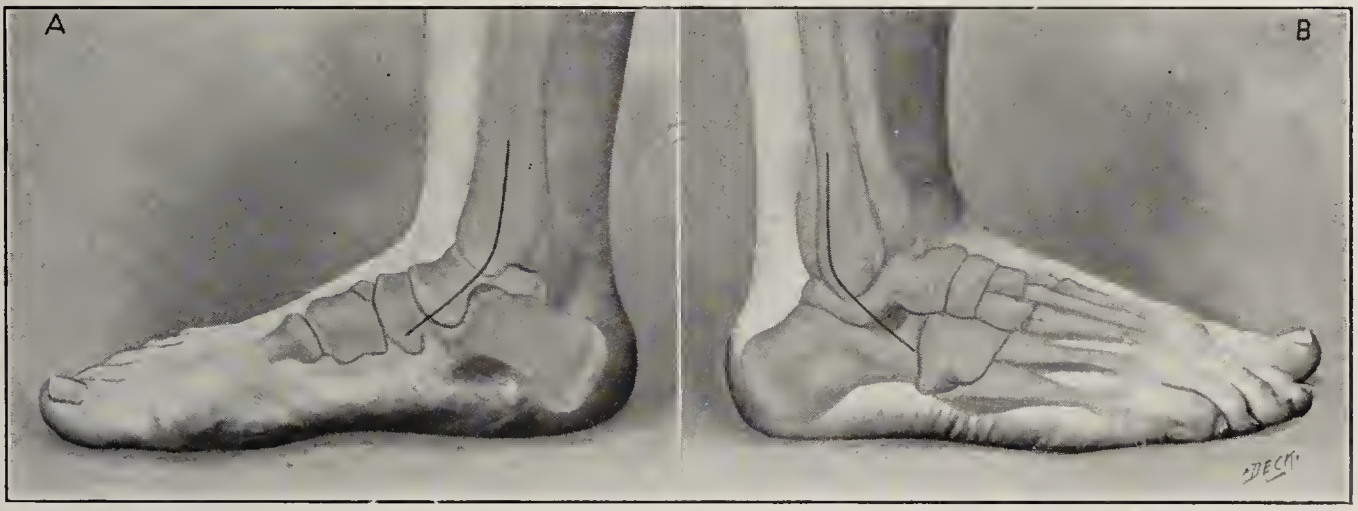

Fig. 871.—Resection of the Ankle-joint by Two Lateral Incisions.
A, The tibial incision; B, the fibular incision.

In **Langenbeck's** original operation the fibular incision is made hook-shaped and the tibial incision anchor-shaped (Fig. 872).

In operations for injuries, and particularly in gunshot wounds, departures from typic methods are to be made, according to the demands of the case. The resection should be subperiosteal as far as possible.

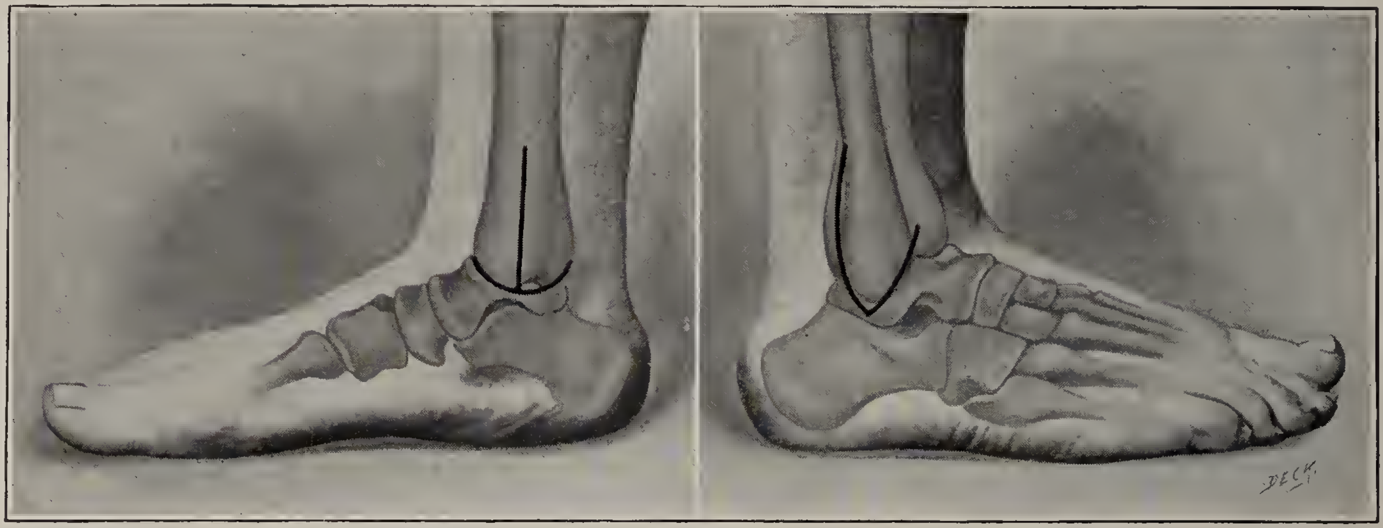

FIG. 872.—LANGENBECK'S INCISIONS FOR RESECTION OF THE ANKLE-JOINT.
A, Inner incision; B, outer incision.

Kocher (1883) operated through an external curved incision and turned the joint surfaces outward (Fig. 873). The foot is held at a right angle and the incision extends from just in front of the tendo Achillis across the tip of the external malleolus to the extensor tendons. After the tendons of the peronei muscles are detached and retracted backward and downward, the ligamentous attachments at the external malleolus are chiseled away. The extensor tendons are retracted anteriorly and the peronei posteriorly; the articular surfaces are turned out between these and chiseled away, if necessary, or a simple **synovectomy** or **arthrectomy** may be performed. Reverdin commenced the incision to the inner side of the tendo Achillis, and divided this and the extensor tendons as well.

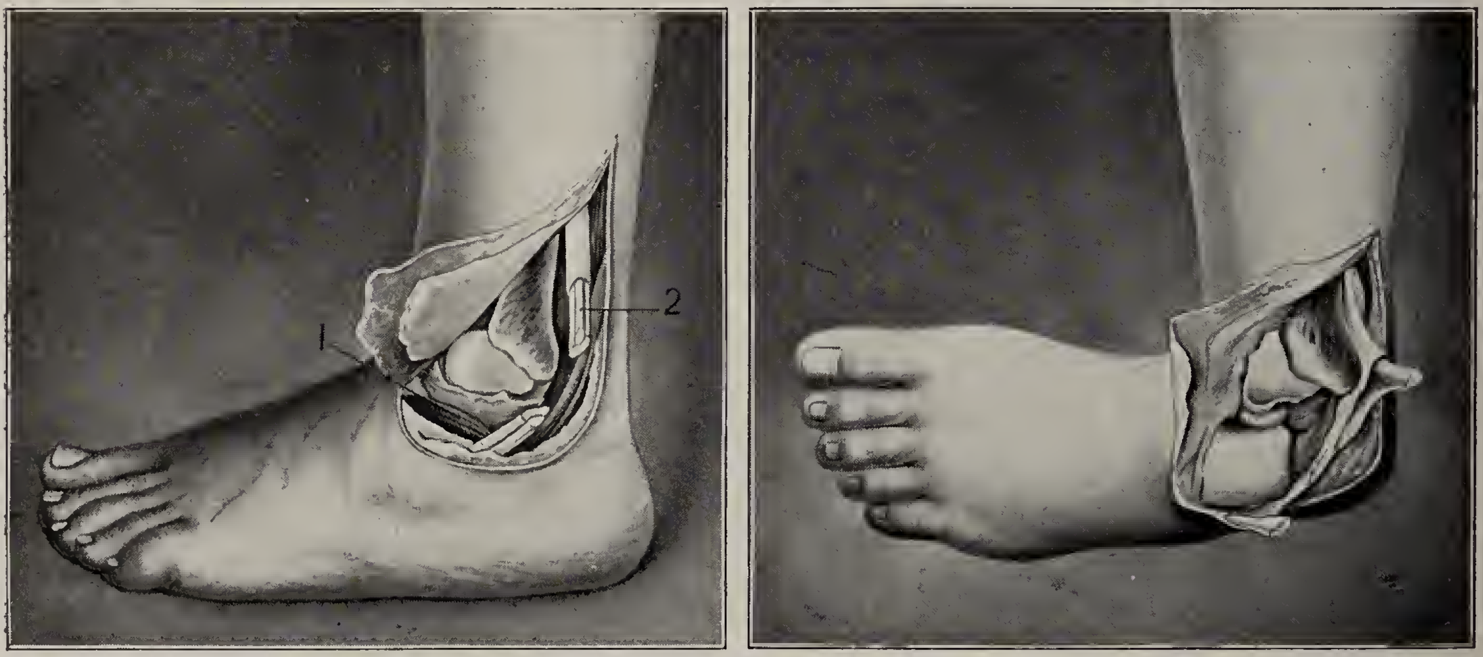

FIG. 873.—KOCHER'S METHOD OF RESECTION OF THE ANKLE.
1, Extensor brevis digitorum muscle; 2, tendons of the peroneus longus and the peroneus brevis.

Hueter revived the **transverse incision** of Heyfelder and Sédillot, but sutured methodically the divided tendons and anterior tibial nerve. The incision commences at the posterior edge of the internal malleolus and is carried across the front of the joint to the tip of the external malleolus (Fig. 874). The tibialis anticus is tied on each side of the place of proposed division and the threads left long and tied together for future identification. The extensor communis digitorum and the extensor proprius hallucis, as well as the anterior tibial nerve, are dealt with in the same manner. The latter tendon is drawn inward when the dorsalis pedis artery and its accompanying veins come into view and are divided between two ligatures. The nerve lies to the outer side of the artery. The tendons and nerve are now held out of the way by means of the threads, the foot forced into plantar flexion, and the anterior capsular wall exposed and incised transversely. The lateral ligaments are divided at the malleoli, the incision extended in an outward direction to expose the peroneal tendons, and these also secured with threads to facilitate identification. The tendons are now divided between the threads, and the ankle-joint opened. This is now dealt with according to the conditions present. The divided tendons and anterior tibial nerve are identified by means of the attached threads and carefully sutured, and the skin wound is sutured except at the external part of the incision, which is left open for drainage. I have employed this method with excellent results.

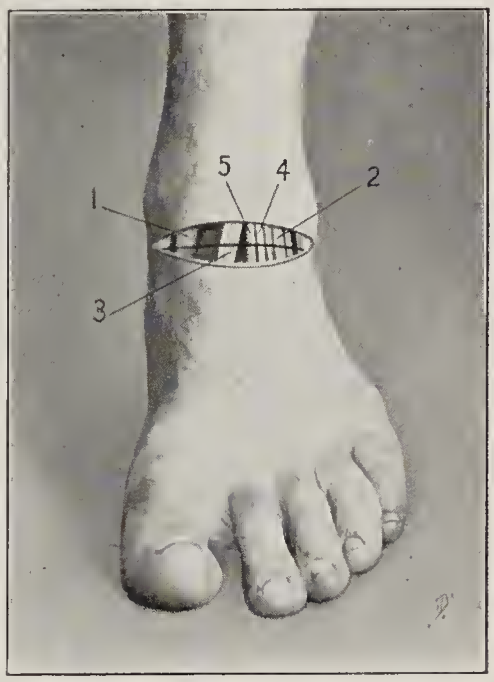

Fig. 874.—Hueter's Resection of the Ankle.

1, Tibialis anticus muscle; 2, extensor brevis digitorum; 3, extensor proprius hallucis; 4, peroneal nerve; 5, anterior tibial artery.

Constant care and watchfulness must be used in the after-treatment to maintain the foot at a right angle to prevent abduction or adduction, and to preserve the foot in a position midway between pronation and supination. **Partial resection** does not give such good final results as complete resection, and efficient drainage is not so easily secured.

The Result of Resection of the Ankle-joint.—In the absence of damage to the periosteum from suppuration, with the exception of tuberculous cases, rapid repair and early usefulness of the foot after subperiosteal resection of the ankle-joint is the rule. The malleoli are reproduced, often at first exceeding in size the original. The shortening is slight in proportion to the amount of bone removed, an extra thickness of the sole of the shoe supplying the deficiency. A joint may form in the fibrous new formation. The mortality, in properly selected cases, is small. In gunshot injuries resection, as a rule, is to be preferred to amputation. An unfavorable prognosis, however, is warranted in cases of tuberculous caries in individuals beyond the period of growth; such cases usually require amputation. If performed early, resection in children and young persons admits of a good prognosis, as regards both life and function.

Resection of the Astragalotarsal Joints.—Removal of the Astragalus.—Isolated gunshot fractures of the head of the astragalus, or of the scaphoid, may require partial resection. This may be accomplished by a transverse incision following the articular line from the inner edge of the tendon of the tibialis anticus to the tendon of the tibialis posticus, and exposing the head of the astragalus. Resection of the posterior portion of the astragaloscaphoid joint alone is more difficult and will require the sacrifice of considerable bone (calcaneum or astragalus). As a rule, the inflammation attacks the ankle-joint, and resection of this becomes necessary, in order to reach the seat of injury.

Combined resection of the astragalotibial and posterior astragalotarsal joint requires the same operation as isolated resection of the former.

Excision of the Astragalus.—Removal of the astragalus alone is most frequently indicated in injury, as, for instance, in otherwise irremediable dislocations of the bone forward (a condition which is almost certain to be followed by sloughing and necrosis) and in irreducible dislocation of the tibia and fibula forward. It is also indicated in otherwise intractable cases of talipes varus and talipes valgus, congenital or acquired, and in tuberculous osteitis of the ankle in which this bone is involved, in order to gain access to the diseased synovial membrane and remove it completely. The operation may be carried out by means of Vogt's longitudinal incision on the anterolateral aspect of the ankle-joint.

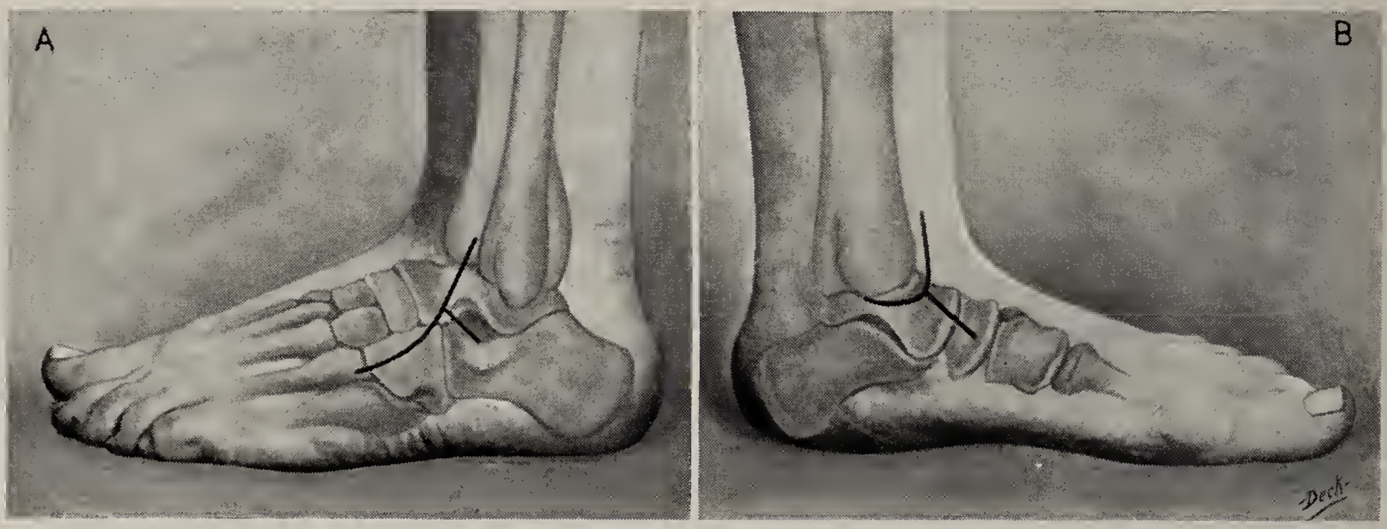

Fig. 875.—Excision of the Astragalus.
A, Vogt's incision; B, Ollier's inner incision.

The incision commences about 2 inches above the line of the ankle-joint, between the tibia and the fibula, and extends forward over the ankle-joint, terminating at the base of the fourth metatarsal bone (Fig. 875, A). The fascia and annular ligament are divided; the tendon of the extensor longus digitorum and that of the extensor brevis digitorum are loosened and both are displaced toward the median line. The ankle-joint, together with the astragaloscaphoid articulation, is now opened, the capsule being loosened from both joints at its insertion on the anterior margin of the tibia and fibula, and the astragaloscaphoid ligament divided. In some instances it may be convenient to carry a transverse incision from the middle of the longitudinal one outward to a point below the malleolus. The external and posterior connections between the astragalus and the os calcis are loosened, and, with the foot in forced supination the anterior and posterior astragalofibular ligaments, as well as the ligamentous structures in the tarsal sinus, are divided with the resection knife or sharp chisel. With the foot strongly adducted an elevator is placed beneath the astragalus and this lifted upward to permit the loosening of the attachment of the posterior fibers of the internal lateral ligament to the astragalus, and the posterior connections of the latter with the os calcis. In order to facilitate the loosening of the attachments of the bone Ollier's inner incision may be added. This incision curves around in front of the internal malleolus, with an arm extending forward and downward (Fig. 875, B).

After removal of the astragalus the os calcis is placed between the malleoli, the wound cavity drained, and the soft parts sutured.

The operation may also be performed by transverse incision, the tendons being marked for identification by threads, as in resection of the ankle-joint by a transverse incision (*vide supra*). The bone is exposed by an incision crossing the dorsum, as in Syme's amputation. Excellent results have followed this method.

Resection of the Tarsal Bones in Talipes Varus and Talipes Valgus.— The operation of **resection of the neck of the astragalus** may be employed for the correction of the position of the foot in **intractable cases of talipes.** Hueter's method is as follows: The incision commences about a fingerbreadth in front of the anterior edge of the external malleolus, and extends to the external edge of the scaphoid. The ankle-joint is avoided. The group of extensor tendons is retracted inward. A pointed saw is introduced, and the bone sawed across parallel to the anterior edge of the tibia, the separated portion being removed after division of the astragaloscaphoid ligament. Should the correction not be sufficient by this simple operation, the scaphoid may be removed through the same wound, and in severe cases the cuboid may likewise be removed, the incision being carried toward the dorsal surface of the cuboid. The periosteum is to be preserved and the tendon of the peroneus brevis avoided. The peroneus longus does not pass over the cuboid in congenital talipes varus, as in the normal foot, but in a groove in the os calcis (*vide supra*).

Removal of the astragalus has already been described. In performing the operation for clubfoot, resection of about a third of an inch of the point of the external malleolus facilitates not only the removal of the astragalus, but also the redressment of the foot. The latter aim may also be reached by division of the calcaneofibular ligament.

Tarsectomy.—Wedge-shaped resection of the tarsus for clubfoot is performed through a transverse or slightly curved incision passing over the most prominent portion of the convexity of the curvature of the foot. The soft parts are dissected back, the extensor tendons being preserved as much as possible, and as much of the tarsus cut or chiseled away as may be necessary to straighten the foot. The mass of bone removed in order to correspond to the curvature of the foot must be wedge-shaped in two directions at right angles to each other, *i. e.*, the base of the horizontal wedge is directed outwardly and includes the cuboid and the anterior process of the os calcis, and its point faces into the scaphoid; the base of the vertical wedge is at the dorsum of the foot (O. Weber, Davies Colley and others). The operation must be followed by redressment and pressure to maintain the reposition. As soon as the wound has healed, the foot is overcorrected and a plaster-of-Paris bandage applied.

Ogston's operation aims to remove the osseous centers from those bones which prevent rectification. It was originally designed for children up to six or eight years of age. I have employed it with perfect satisfaction in young adults. The outline of the astragalus is exposed through a skin incision which begins in front of the external malleolus and curves with its convexity downward until it reaches the calcaneo-cuboid joint. The soft parts overlying the astragalus are incised and retracted; in the case of young children the cartilaginous shell of the bone is included in this incision. In the case of adults the author's method is to gain access to the interior of the bone by means of an opening made with a chisel. By means of a Bruns curet or a Volkmann sharp spoon introduced through the opening the greater portion of the interior of the bone is scraped away. The portion lying between the malleoli is left undisturbed. If necessary, portions of the cuboid and os calcis can be scraped out through the same opening. The foot is now forced in position, the thin shell left behind readily adapting itself to the corrected shape of the tarsus, the wound sutured, and the parts immobilized with plaster-of-Paris.

Resection of the Tarsus, the Metatarsus, and the Toes.—Resection of the os calcis is most frequently indicated for tuberculous osteomyelitis and occasionally for gunshot injuries. A horseshoe-shaped incision encircles the bone, commencing on the outside of the foot at the articulation between the cuboid and the anterior process of the os calcis, passing to the insertion of the tendo Achillis and thence to the inner edge of the foot, and terminating at the astragaloscaphoid joint. Linhart added to this a short vertical incision at the inner edge of the tendo Achillis. The circumscribed plantar flap thus marked out, together with the plantar aponeurosis, is dissected back, the muscular structures and the periosteum separated from the bone by the elevator, as well as the tendo Achillis and the tendinous structures on the inner and the outer side of the bone, without opening their sheaths. The articulation with the cuboid is first separated; then the connection between the astragalus and the os calcis is severed. The bone is removed and the wound sutured in part, and drained. The reproduction of bone is greater after gunshot injuries than after tuberculous disease. Over 30 per cent of 69 cases collected by Vincent resulted unfavorably. This was due to the loss of the posterior support of the arch of the foot. In view of this fact the incision of Ollier should be considered, in which, unlike the horseshoe-shaped incision, the heel flap may be subsequently utilized in a Syme's amputation, should this become necessary. Ollier's incision commences a fingerbreadth above the tip of the external malleolus on the outer border of the tendo Achillis, is carried downward to the lower border of the os calcis, where it is carried forward at right angles nearly to the base of the fifth metatarsal bone. This incision is not nearly so convenient for the removal of the bone as the horseshoe-shaped one, but, in case of a subsequent Syme's amputation, only a comparatively small amount of scar tissue is present in the flap, and that is not so inconveniently placed for walking as in the first described.

Extirpation of the cuboid and cuneiform bones may be required for gunshot and similar injuries, and for tuberculous disease. Their removal for the correction of clubfoot has already been discussed. The incisions usually refer to the dorsum of the foot, care being taken to avoid injury to the tendons. Resections for tuberculous osteomyelitis often consist of *évidement* of the diseased medullary tissues, the healthy cortical substance being left and the joints remaining unopened. Recurrences, however, are not uncommon, in which case amputation becomes necessary.

Resection of the metatarsal bones is indicated by tuberculous osteomyelitis, and occasionally by **enchondroma.** The technic is practically the same as in the metacarpal bones. Every effort should be made to avoid opening the tarsometatarsal joints on account of the dangers attending infection and suppuration in the tarsus.

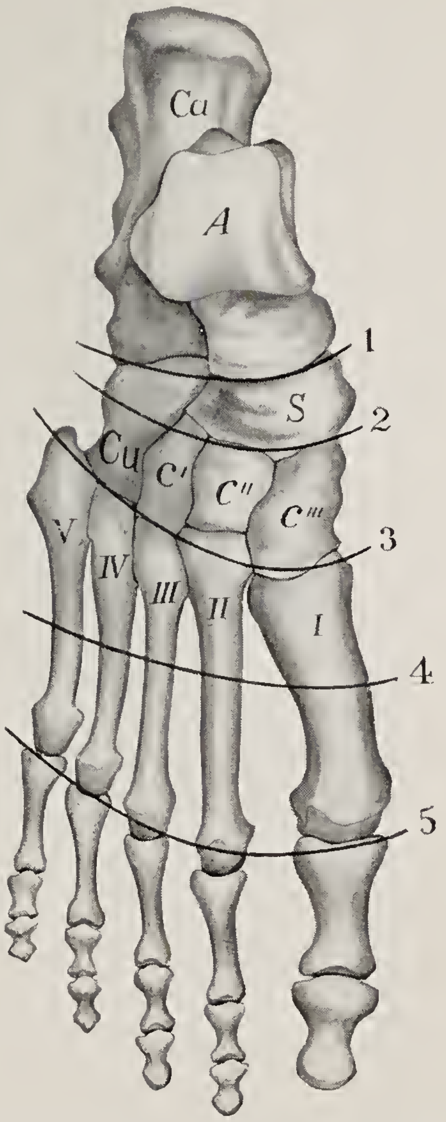

Fig. 876.—Schematic Representation Explanatory of the Amputations of the Foot.

Ca, Os calcis; *A*, astragalus; *S*, scaphoid; *Cu*, cuboid; *C'*, *C''*, *C'''*, cuneiform bones; *I*, *II*, *III*, *IV*, *V*, metatarsal bones. 1, Chopart's amputation; 2, Bona's amputation; 3, Lisfranc's amputation; 4, amputation through the metatarsal bones; 5, amputation through the metatarsophalangeal joints (after Hueter).

Resection of the metatarsophalangeal joints is indicated in the case of the great toe almost solely by hallux valgus (see page 622).

Metatarsal Amputation.—This is the oldest partial amputation of the foot (Sharp, 1765). Two longitudinal incisions are made, one on each side of the foot, the one extending from below the base of the first, and the other from the base of the fifth metatarsal bone. A dorsal and a plantar incision connect these two, and a dorsal and a plantar flap are dissected back; the soft parts in the interosseous spaces are cleared with a narrow knife. The saw is now applied.

Lisfranc's amputation consists of a disarticulation at the line of the tarsometatarsal joint (Fig. 877). The junction of the cuboid and the fifth metatarsal is identified on the outer side of the foot, and the junction of the first or internal cuneiform and the first metatarsal bone on the inner side. The thumb of the surgeon's left hand is placed on one of these points and the point of the index-finger on the other, while the palmar surface of his hand presses the foot in the direction of plantar flexion and adduction. The two points are now connected together on the dorsum by a curved incision with its convexity directed forward. The line of the tarsometatarsal joint is now exposed by dissecting the flap back, and disarticulation effected by a narrow knife, the incision commencing at the fifth tarsometatarsal joint, which is the most easily identified. The joints are made to gape by manipulating the anterior portion of the foot. The fifth, fourth, and third are disarticulated in succession, and the first tarsometatarsal joint next, that between the second metatarsal and the second or middle cuneiform bone being left until the last. When all the joints are fully opened, a longitudinal incision is made on each side of the foot, an amputating knife is passed in the gap and a plantar flap cut, its lateral margins corresponding to the longitudinal incisions and extending as far as the anterior extremities of the metatarsal bones (Fig. 877).

The loss of support following Lisfranc's amputation is such that the patient must wear a specially constructed cork sole made thick on the front and inner side, to compensate for the resulting equinovarus position.

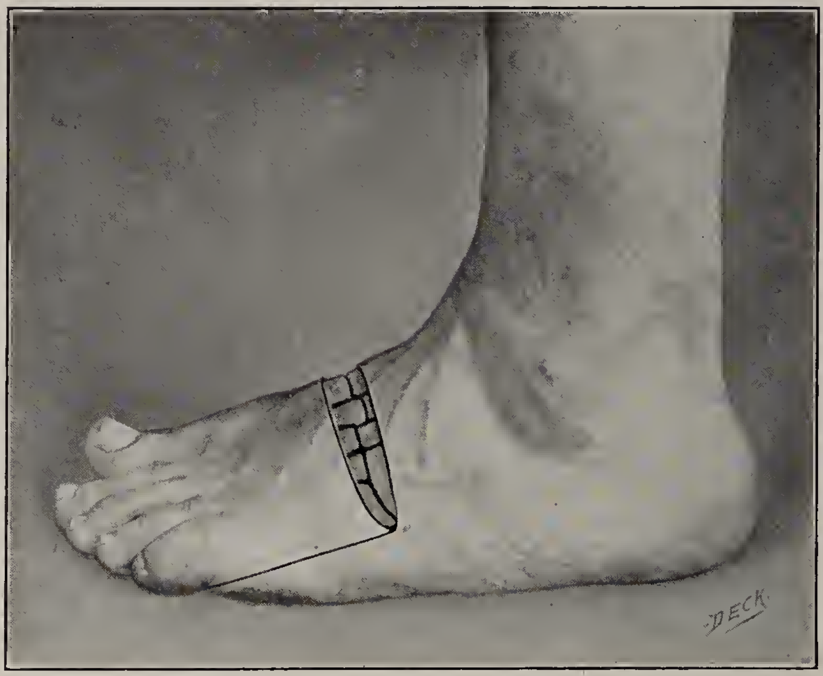

Fig. 877.—Lisfranc's Amputation.

In **Chopart's amputation** only the os calcis and the astragalus are left. While the operation is simpler than Lisfranc's, its functional results are unsatisfactory. It has been abandoned to a large extent for either Pirogoff's or Syme's amputation in the cases in which Lisfranc's cannot be employed. The lines of incision are shown in Fig. 878. The disarticulation is effected by passing the knife behind the tubercle of the scaphoid between the bone and the astragalus and then between the os calcis and the scaphoid (Jacobson). In closing the wound the divided ends of the extensor tendons are sutured in the fibrous tissue of the heel flap as this is brought into position, to prevent the subsequent tilting upward of the heel. Helferich, in furtherance of the same object, recommends producing ankylosis of the ankle-joint by opening the joint and removing the cartilage with a sharp spoon, and immobilizing the joint.

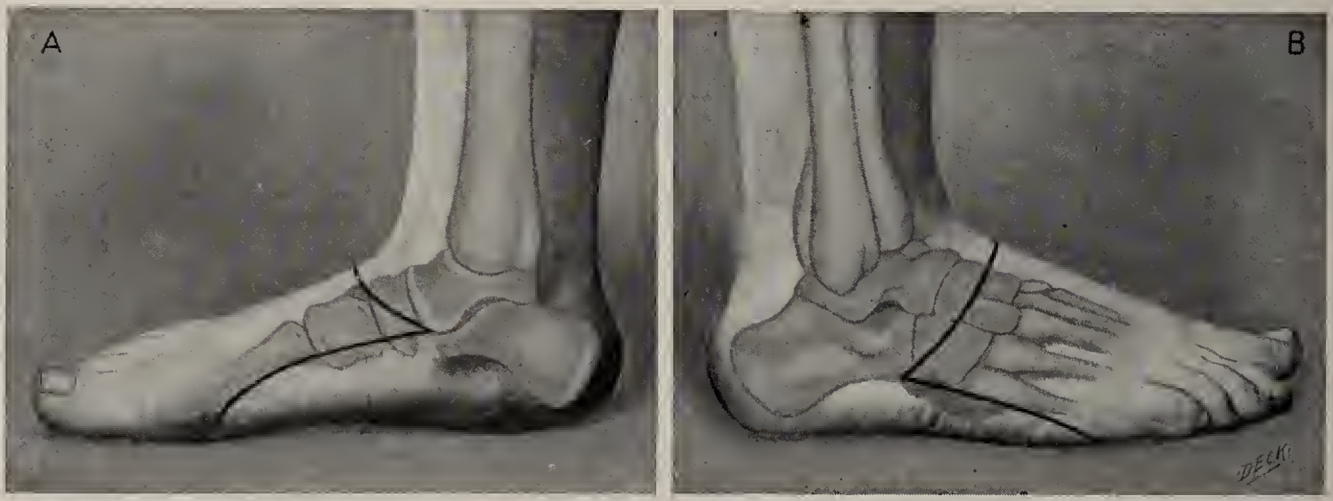

Fig. 878.—The Lines of Incision in Chopart's Amputation.

Pirogoff's method consists in a supramalleolar amputation with the formation of a heel flap containing a portion of the os calcis. This valuable method is carried out as follows: The foot is drawn over the edge of the operating table and held at right angles to the leg. The incision is made from slightly below the lower edge of one malleolus downward and somewhat forward, across the sole of the foot and upward and backward on the opposite side to the lower edge of the other malleolus. This incision is carried directly to the bone. The saw is now applied and the tuberosity of the os calcis sawed across (Fig. 879). This is effected in a vertical direction if the original method of Pirogoff is followed (Fig. 880), or from behind forward and downward according to Günther's modification (Fig. 881). In case the latter is employed the stirrup-incision is carried more obliquely forward. The extremities of the first incision are now united by a transverse cut over the dorsum, the ankle-joint entered from in front, the lateral ligaments being first divided in order to cause the latter to gape widely. The removal of the foot is now completed by severing the connection of the astragalus and the portion of the os calcis to be removed. The lower extremities of the tibia and fibula are now cleared of soft parts, the knife being kept close to the

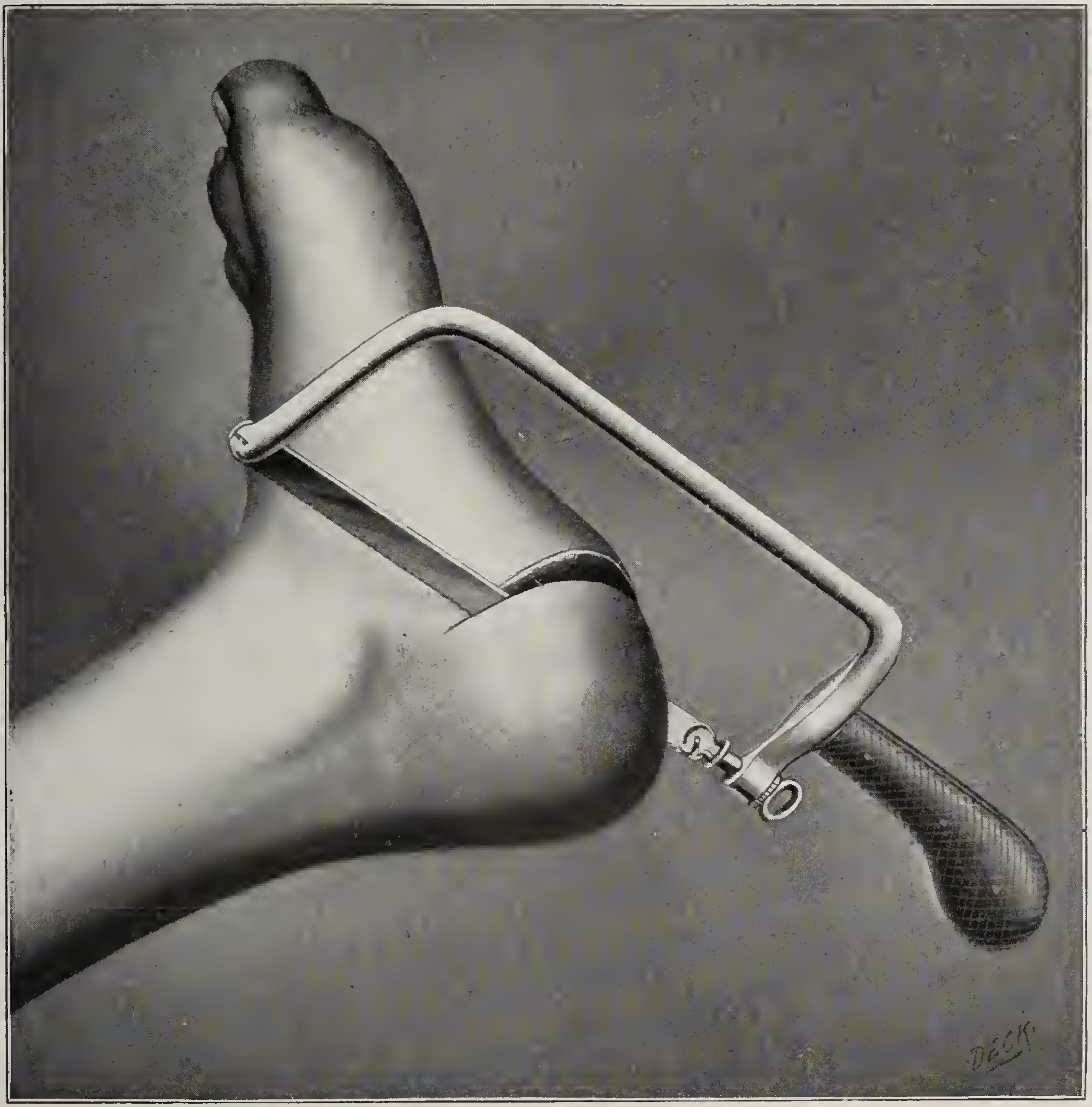

Fig. 879.—Pirogoff's Amputation.
Division of the os calcis from the sole of the foot.

bone posteriorly (Fig. 883), and special care is taken to avoid injury to the posterior tibial artery, the preservation of which is essential to the nourishment of the heel flap. The bones of the leg are now divided just above the malleoli (Fig. 884), the latter being steadied by the lion-jaw forceps during the division. The anterior tibial artery is found on the anterior surface of the tibia at the side of the tendon of the extensor proprius hallucis; the posterior tibial artery will be found to have been divided on the inner aspect of the

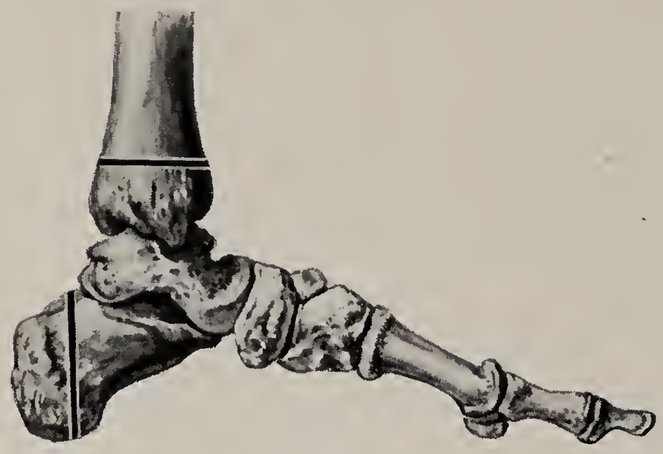

Fig. 880.—The Lines of Section of the Bone in Pirogoff's Original Operation.

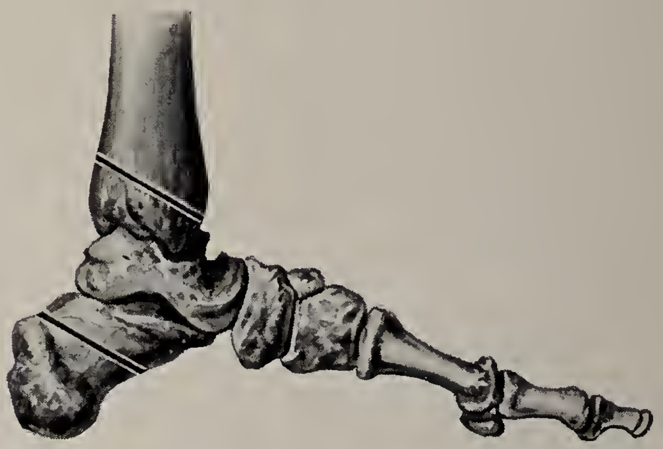

Fig. 881.—Günther's Modification of Pirogoff's Amputation.
The lines of section of the os calcis and tibia.

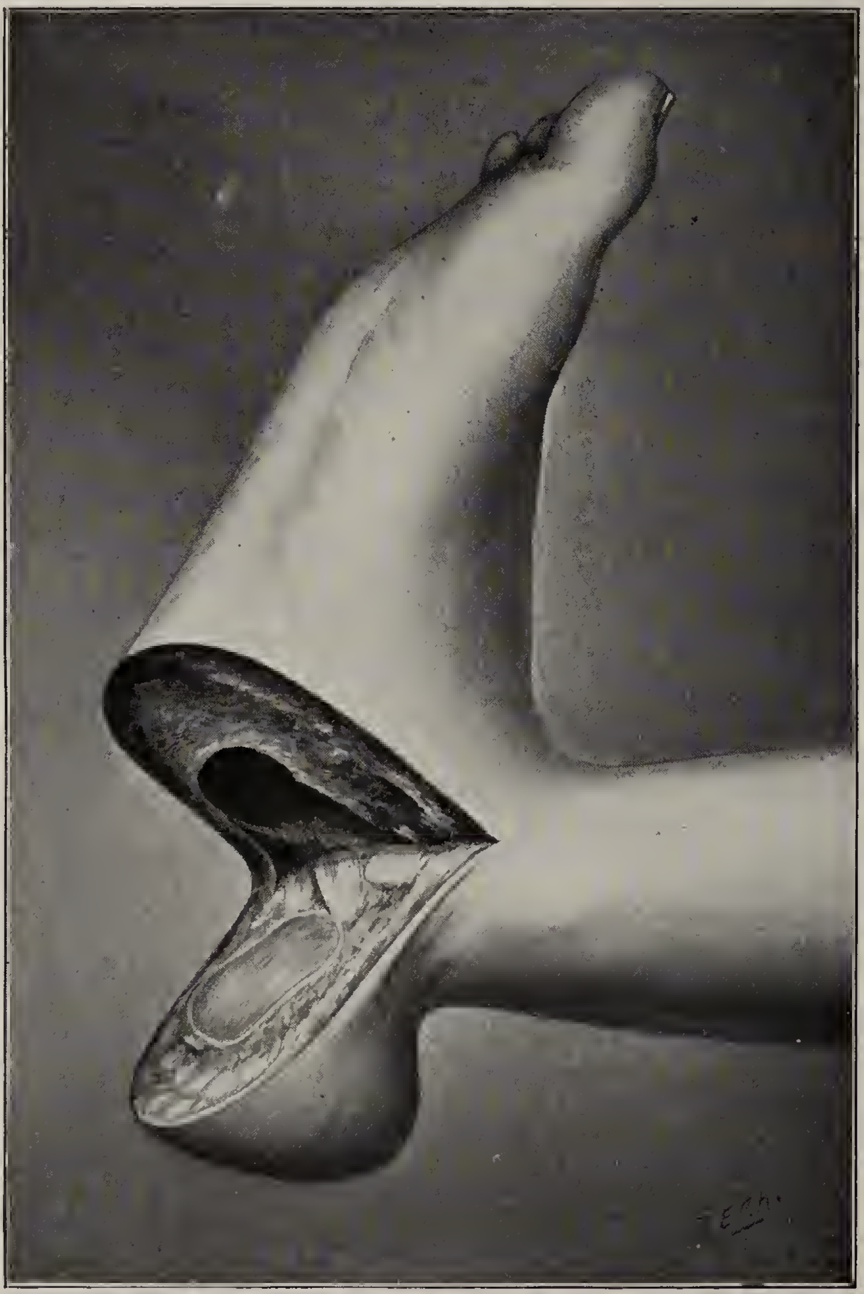

Fig. 882.—Foot after Section of Os Calcis in Pirogoff's Amputation.

heel flap, at about the middle of the vertical incision. The wound is sutured transversely and a drainage-tube placed in position (Fig. 886). Firmly applied dressings suffice to hold the bone surfaces in apposition without the aid of bone sutures or ivory pegs.

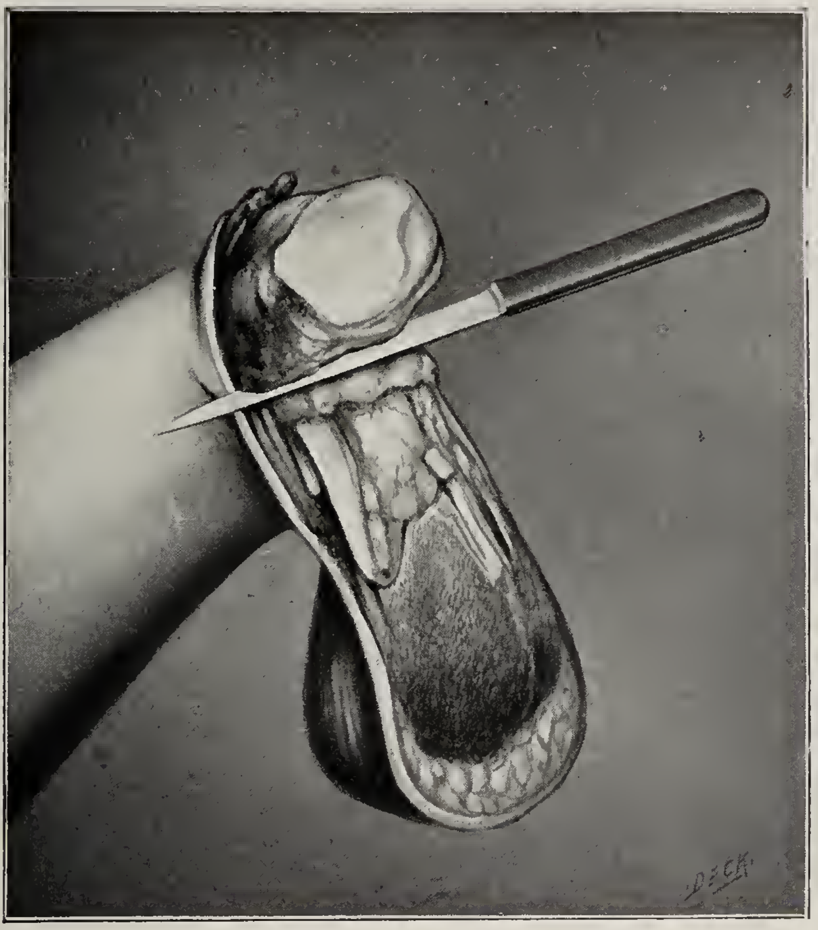

Fig. 883.—Pirogoff's Amputation.
Detachment of soft parts on the posterior aspect of the tibia.

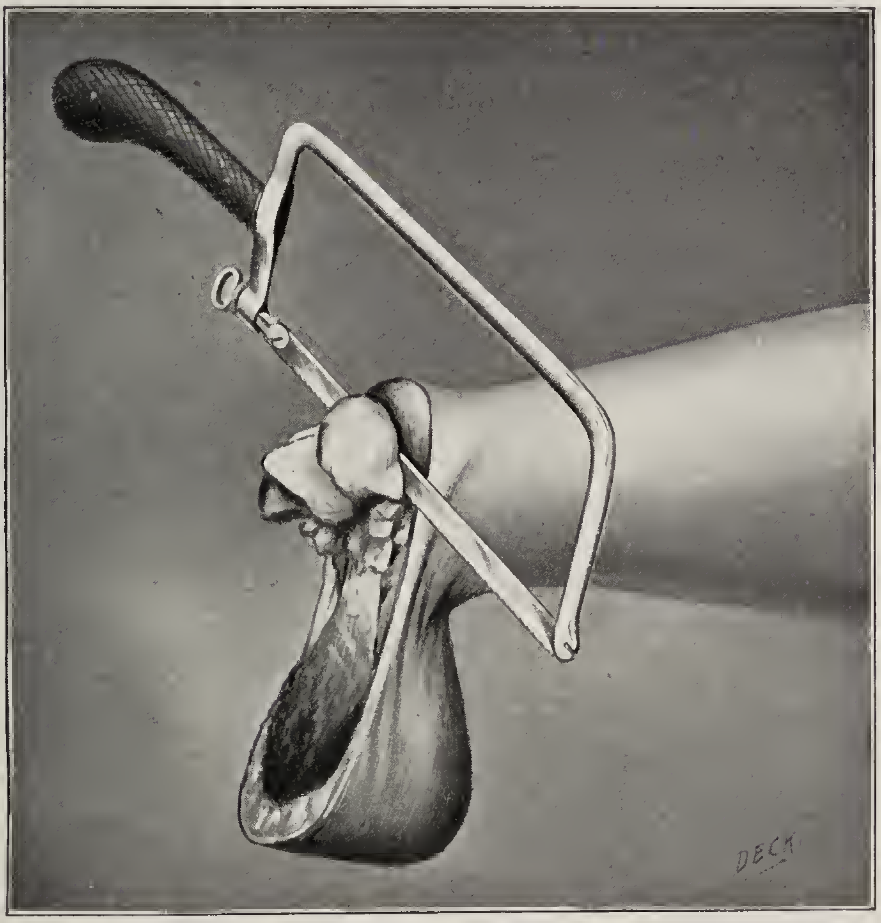

Fig. 884.—Pirogoff's Amputation.
Division of the bones.

In **Lefort's modification of Pirogoff's amputation** the bone is sawed almost horizontally, in order to secure its lower surface for walking, as in the normal (Fig. 885), instead of employing the posterior surface of the tuberosity, as in Pirogoff's original method (Fig. 880). In carrying out Lefort's procedure the dorsal incision commences about a fingerbreadth below the tip of the external malleolus, is carried with a slight convexity forward to the mediotarsal joint, and ends about an inch and a quarter in front of and below the internal malleolus. The plantar incision is about the same as Günther's. The foot is removed by disarticulation at the ankle-joint, and at the articulations of the astragalus and cuboid with the os calcis, the latter being left in the heel flap and afterward sawed across. The functional results obtained by Lefort and Boeckel were very satisfactory. In **Bruns's modification** the os calcis is sawed concavely, and the bones of the leg convexly. In cases in which the external surface of the heel is not available as a flap Tauber takes the osteoplastic flap entirely from the inner side, saws through the os calcis vertically, and places the inner portion of the latter against the sawed surface of the leg bones. The incision commences at the external edge of the tendo Achillis and passes horizontally along the external surface of the heel just below the external malleolus to Chopart's joint. Following the latter it crosses the dorsum to the internal edge of the foot and thence to the middle line of the plantar surface, where it turns backward at a right angle and follows the middle line of the plantar surface longitudinally until it reaches the point of commencement. The ankle-joint is now opened, the astragalus disarticulated, and the anterior portion of the foot removed at Chopart's joint. The os calcis is now sawed through vertically in its longitudinal axis, the external

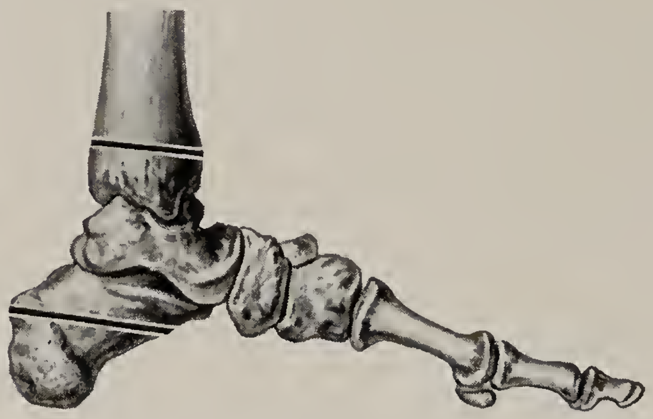

Fig. 885.—The Line of Section of the Bone in Lefort's Modification of Pirogoff's Amputation of the Foot.

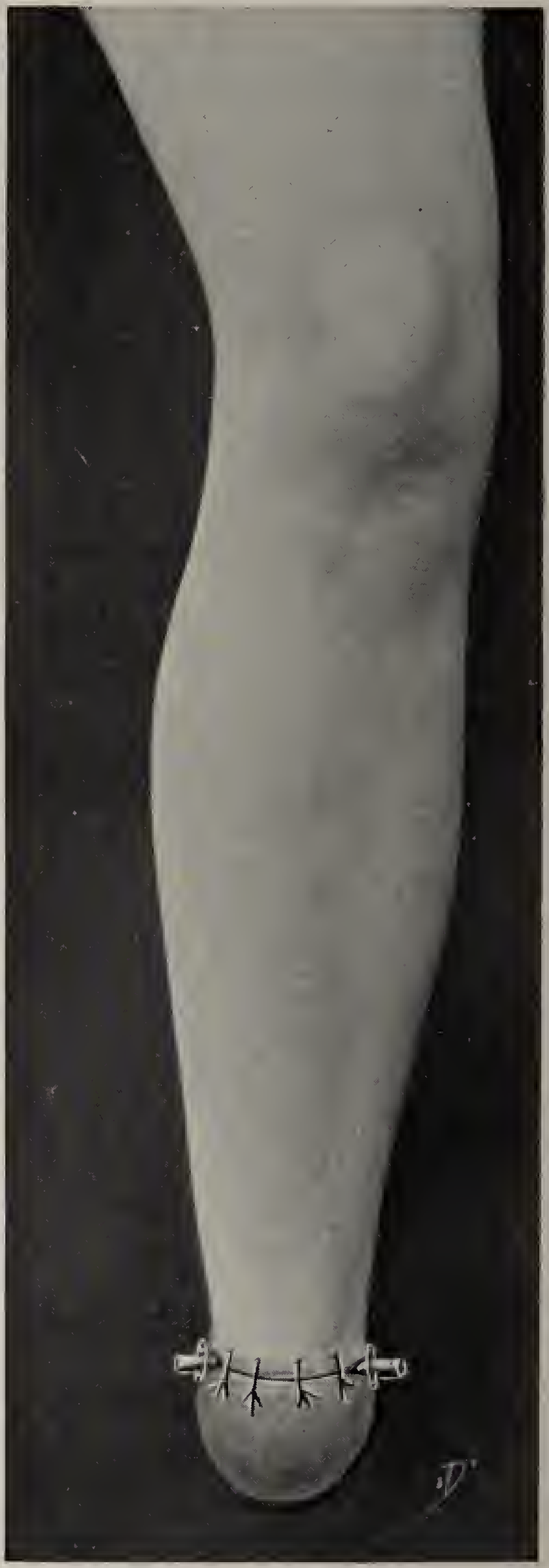

Fig. 886.—Stump after Pirogoff's Amputation.

portion removed, and the internal portion lying in the flap turned upward against the sawed surface of the leg bones. One of the advantages of this method is the certain preservation of the posterior tibial artery.

Osteoplastic Resection of the Tarsus by the Wladimiroff=Mikulicz Method.—This operation is of great value in cases of gunshot wounds and in extensive disease of the tarsus and ulcerative destruction of the heel. The operation has also been performed in paralytic talipes equinus. Mikulicz operated as follows: The first incision extends from just in front of the tuberosity of the scaphoid transversely across the sole to a point a quarter of an inch behind the tuberosity of the fifth metatarsal bone. This incision is carried directly to the bone. Two oblique lateral incisions are now made, one on each side, extending from each end of the first incision upward and backward to the posterior border of each malleolus. A final transverse incision connects the upper ends of the last named, passing transversely behind the leg to the bone, dividing the tendo Achillis (Fig. 887). The foot is now sharply flexed and the ankle-joint opened from behind. The lateral ligaments are divided, the astragalus and the os calcis removed, and thin disks of bone sawed from the lower extremity of the bones of the leg and the articular surfaces of the scaphoid and cuboid. Tenotomy of the plantar flexor tendons is performed in order to permit the toes to assume a rectangular dorsal flexion. The anterior portion of the foot, which is attached by the soft parts of the dorsum, is now brought into coaptation with the sawed surfaces of the tibia and fibula and sutured.

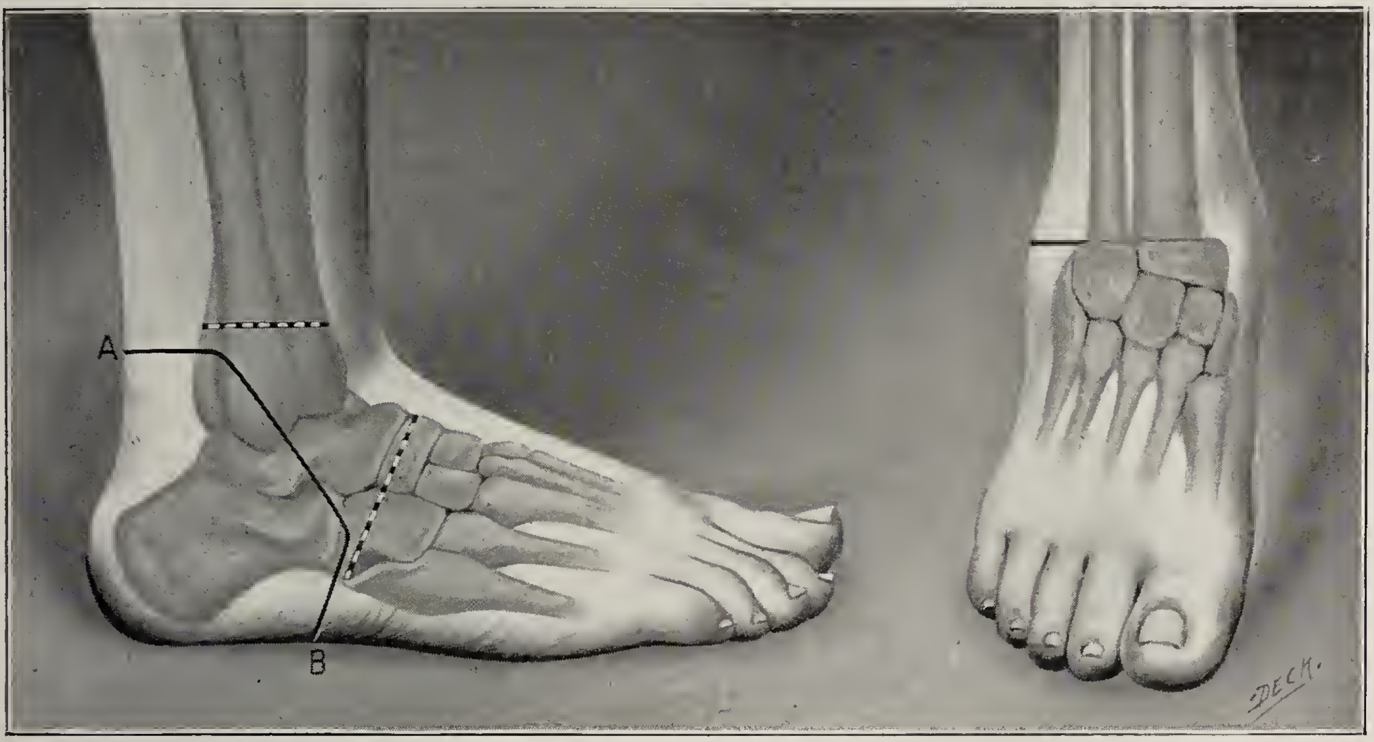

Fig. 887.—The Wladimiroff-Mikulicz Osteoplastic Resection of the Tarsus. A B, The solid lines show incisions of the soft parts (these are alike on both sides). The dotted lines represent the points of section of the bones.

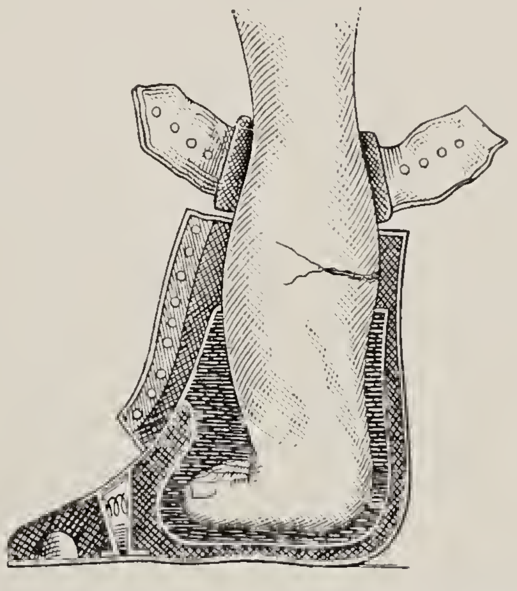

Fig. 888.—Result of Osteoplastic Resection of Tarsus, with Shoe (the Wladimiroff-Mikulicz Operation).

Zesas (1886) collected 24 cases of this operation. Among 19 cases in which the indications for the operation and the final functional results were ascertained, it was found to have been performed 16 times for tuberculous caries, once for syphilitic ulceration, once for injury of the soft parts of the heel, and once for fracture of the leg resulting in deformity. The majority of the patients walked well.

Syme's Amputation.—Amputation of the foot with the removal of the malleoli and the covering of the sawed surfaces of the latter by a heel flap was originally proposed by Jaeger. It was first actually performed by Syme. The method is almost entirely superseded by Pirogoff's method except in cases in which the os calcis is actually diseased. The incisions in the soft parts are the same as in Pirogoff's operation; the os calcis is enucleated from the heel flap. The malleoli are sawed off at a very slight angle; the horizontal plane of cartilage covering the end of the tibia is not removed. The projecting tendons are to be cut the proper length, the skin wound sutured, and drained from the outer side. In Schede's study of 596 cases of Syme's amputation there developed a mortality of nearly 11 per cent, and functional failures in 10 per cent. These figures are not so favorable as in Pirogoff's amputation. While the latter may replace Syme's in proper cases, there can be no question that Syme's amputation should, whenever possible, replace deep amputation of the leg.

Kummer, of Geneva, removes the os calcis subperiosteally as in Syme's amputation, divides the bones of the leg, as in Pirogoff's amputation, and treats the wound openly for four and a half weeks, during which time the dead space left by the removal of the os calcis fills in, after which the heel flap is sutured with secondary sutures. He claims that the bone portion of the Pirogoff heel flap soon atrophies and becomes useless, and that his modification of Syme's operation does away with the objectionable dead space and gives a firmer support in walking.

Amputation of the Toes.—This is required with relative frequency for gangrene the result of frost-bite. Single toes are amputated in precisely the same manner as the fingers (see page 497). To amputate all the toes at the metatarsophalangeal joint the toes are held in dorsal flexion, and a curved plantar incision is made from the inner border of the metatarsophalangeal joint of the great toe to a corresponding point on the little toe. This incision approaches as closely as possible to the commissures, which, on the plantar surface are placed about half an inch more anteriorly than on the dorsum, so that an increased length is afforded to the plantar flap. The ends of this incision are joined by a similar curved incision on the dorsum over the bases of all the toes. The flaps are dissected back and each toe disarticulated separately. It may be necessary to saw off the heads of the metatarsal bones in order to approximate the edges of the flaps without tension. A small drainage-tube is placed transversely under the suture line. In amputation of a toe with its metatarsal bone, the same rules are followed as in the case of the hand.

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